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Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.
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ACTORS GOVERNING THE SUCCESSFUL SHIPMENT OF ORANGES FROM FLORIDA.[1]

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INTRODUCTION.

The citrus-fruit industry of Florida is preeminently first among the agricultural and siness interests of the State. According to the figures of the last United States sus there were 3,864,514 orange trees in the State in the spring of 1910, 2,766,618 of se being of bearing age and 1,097,896 nonbearing. The yield of the 1909 orange p, as given by the census of 1910, was 4,852,967 boxes, valued at $4,304,987. From best sources obtainable at the present time,[2] the citrus crop of Florida during the on of 1912–13 amounted to 28,428 carloads, or 8,125,465 boxes, of which approxiely 5,769,079 boxes, or 71 per cent, were oranges; approximately 2,031,367 boxes, 5 per cent, were grapefruit; the balance, of approximately 325,019 boxes, or 4 per , being tangerines, kumquats, and limes.

uring the winter of 1894–95 there occurred in Florida two very severe freezes, which ught great havoc in the groves of the State and permanently changed the character ıe citrus industry. Present conditions date from that season to a great extent. ording to Hume[3] there were 5,055,367 boxes in the crop of 1893–94, and the output ıe following year would doubtless have reached 6,000,000 boxes. Exceptionally emperatures, interspersed with periods of warm, growing weather, proved fatal, ver, and a large number of trees were either killed outright or had practically all eir bearing wood destroyed. Instead of 6,000,000 boxes, the crop of 1894–95 was ed to 75,000, as a consequence. It will be seen, therefore, that so far as production ıcerned, the Florida citrus industry is now just regaining the position which it at the time of the freeze of 1895.

LOCATION OF THE FLORIDA CITRUS INDUSTRY.

vious to the freeze of 1895 the citrus industry of Florida was largely centered in Orange, and Marion Counties. After the destruction or serious damage to a large er of the best groves in these sections some of the owners became discouraged and

ort on harvesting, handling, and shipping experiments made on a commercial scale through seven g years, showing that decay can be materially lessened by greater care and the avoidance of ical injury to the fruit.

e figures were furnished by the Florida Citrus Exchange.

ne, H. Harold. Citrus Fruits and Their Culture. Jacksonville, Fla., 1904, p. 4.

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Monograph
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either went north to engage in other enterprises or sought locations for their new groves farther south, where conditions were considered safer. Since many of the older groves have been reestablished, the industry has become widely scattered over the State. Plantings now extend in a narrow fringe along the east coast, from St. John County on the north to below Miami, in Dade County, and along the west or Gulf coast they reach from Citrus County almost to the southern boundary of Lee County. Extensive plantings extend diagonally across the State from Volusia County on the east to Hillsboro, Manatee, De Soto, and Lee Counties on the west, including large sections of Brevard, Orange, Lake, Sumter, Hernando, Pasco, and Polk Counties, in addition to those already mentioned. Sections in Marion, Alachua, Citrus, and Osceola Counties also are devoted to citrus fruits. Figure 1 shows a map of the State with the location of the citrus plantings indicated by shading.

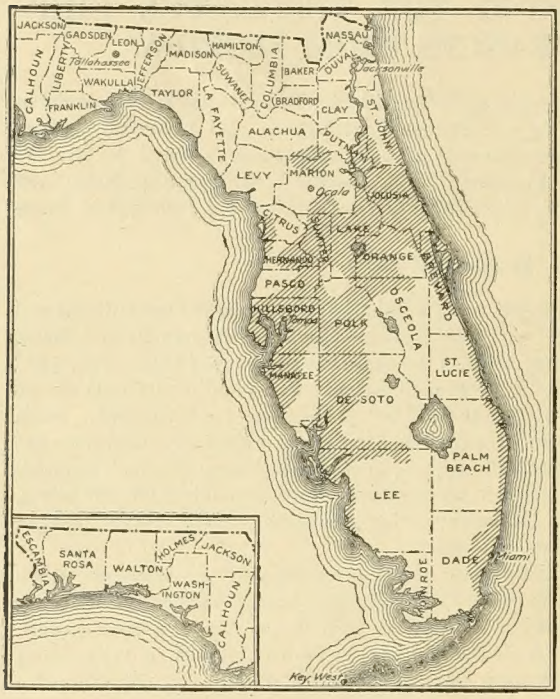

FIG. 1.—Map of Florida, with the location of the principal citrus plantings indicated by shading.

The difficulties of handling and marketing crops of fruit produced in groves scattered over so wide a territory are manifestly greater than where the plantations are confined to a more restricted territory. Where groves are located comparatively close together, as was the case in many of the older citrus districts of Florida, a neighborhood competition is stimulated, especially in the production of clean, bright fruit of fine texture. There has probably never been a region where so many varieties of oranges have been developed and tested as in what, before the freeze, were the old neighborhood centers of production, or where more strenuous efforts have been made to produce fruit of fine texture and flavor. Moreover, a special effort was made to pack the fruit in an attractive manner and to have it reach the market without decay. At present, with the groves so widely scattered throughout the State, there is much less personal contact between growers, and the old neighborhood competition in the production of fancy fruit has largely disappeared. Although the industry has become better organized during the last few years, it is extremely difficult to make effective any association which represents so many diverse interests and whose members are so widely scattered. This situation has proved a great barrier to the introduction of better handling and marketing methods.

HISTORY OF THE FLORIDA CITRUS INDUSTRY.

It is believed that the orange was originally introduced into Florida by the Spaniards, who imported a few sour oranges and gave some of the fruits to the Indians. The seeds of these fruits, being distributed from village to village and finding congenial

nd favorable climatic conditions in the hardwood forests and live-oak groves, the tall native growth protected them from sun and radiation, grew up into seedling trees, and in time formed wild groves of immense extent throughout the northern and central parts of peninsular Florida.[1] Although sweet oranges were known in Florida before the Civil War, they were not considered of commercial importance because of the absence of transportation facilities. Commercial orange culture dates back to between 1865 and 1870, when the success of the trees along the banks of the St. Johns River began to attract attention to this industry as a good investment. As the profits were large from the first, many were thereby induced to engage in the business, and the industry gradually expanded until in 1895 the production had reached nearly 6,000,000 boxes.

Transportation problems and market conditions have changed considerably since Florida reached its highest point in citrus production before the freeze. First of all, the citrus industry of California has been largely developed since that time. Through the establishment of efficient transportation facilities and modern refrigerator-car service, the California growers have been enabled to distribute their fruit over practically every State in the Union. In the early days of the industry, the Florida orange growers did not have to meet the keen competition which has developed in recent years, and therefore the condition of their fruit upon its arrival in the market did not affect the selling price as much as it does at present. The market demand for Florida oranges was strong, and fair prices were usually obtained in spite of the presence of considerable decay. As the production increased just prior to 1894–95, less favorable prices were being received, and at the time of the freeze efforts were being made to extend the market both at home and abroad and to produce fruit of better keeping quality.

The formation during that period of the Florida Fruit Exchange may be considered as an effort among the growers to obtain better marketing conditions, induced, it is thought, by the necessity of improving the quality and condition of fruit in the markets. Although the Exchange failed to accomplish the special object for which it was created, it did prove that Florida oranges often failed to reach the northern markets in sound condition. Notwithstanding the general impression now current among growers that the decay of oranges was unknown before 1894, it seems to be well established that for many years the fruit has shown considerable waste.

A few reports taken from the current issues of the trade papers will serve to show that even at that time the decay problem was of considerable importance. In the issue of December 23, 1893, of "The Florida Despatch Farmer and Fruit Grower," under the Buffalo-New York fruit-sales letter, a statement was made which is characteristic of many others and serves to illustrate the wasted condition in which the fruit often reached the market. This report reads, in part:

> Very sorry to report that the fruit is still coming forward in poor condition. . . . About 1,400 boxes, good and bad, mostly all of which showed more or less decay, averaged $1.51.

Under date of December 2, 1893, the following report is given:

> The dealers and handlers throughout the country are worn out with the constant labor of repacking, in the effort to save something out of the ruins of the decay, and to save the fruit from going bodily to the dump. Buyers are afraid to take hold, because they have no assurance of getting an article that will hold together until they can get rid of it.

Out of 19 telegraphic reports, 12 mention fruit showing decay, using such remarks as: "Both much decayed," "Some lots in very bad order," "Oranges mostly decayed," and "Very rotten." It will thus be seen that the conditions which are conducive to the occurrence of decay were present in the early days of the industry.

[1] Mead, Theodore L. The orange. Article in Cyclopedia of American Horticulture, 1901, p. 1154.

With the extension of the plantings consequent upon the reestablishment of the industry, and the resulting increase in production, existing conditions have been largely responsible for the improper handling of the fruit, which has been shown by later investigations to be the fundamental factor underlying the occurrence of decay. Many of the new groves established since the freeze have been planted on pine land, where it has been necessary to use heavy applications of fertilizers. Frequently the fertilizers have been selected with the purpose of producing large crops rather than fancy fruit, and this seems to have been at the expense of quality, thus partly accounting for the large proportion of rough and unattractive oranges now to be found in the Florida crop. The production of large quantities of rather coarse and uninviting fruit has in turn led to rough and careless handling, for, as a general rule, the more attractive the fruit the greater will be the incentive to handle it carefully when preparing it for shipment.

In addition to the freeze, unfavorable conditions have existed which have more or less discouraged many growers and which have led to the production of inferior fruit, with a correspondingly increasing tendency to place it on the market in a manner not conducive to the best results. The control of the white fly, which has spread over practically every citrus district in Florida, has been a serious problem. Fruit which has been rendered unattractive through the attacks of this pest presents one of the most discouraging problems which growers have to solve, for it is difficult to make workmen who pick, grade, and pack unattractive fruit realize the importance of careful handling. The sooty-mold fungus follows the attacks of the white fly, covering the leaves and fruit with a dense black growth which detracts greatly from the appearance of the oranges, and in order to prepare this smutty fruit for market, cleaning is absolutely necessary. The effects of the cleaning processes upon the carrying quality of the fruit will be described later.

The market demands high-grade, well-packed fruit. As long as the supply of a commodity does not equal the demand, a poorer grade or a less attractive package may yield satisfactory returns to the shipper. With keen competition, however, and markets well stocked with good, carefully selected fruit arriving in sound condition, the packer of a poor grade of fruit which frequently arrives in bad order is at a great disadvantage and suffers accordingly.

METHODS OF HANDLING THE FLORIDA ORANGE CROP.

The Florida orange begins to ripen in late October or early November, and the shipping season extends until spring, some growers of late varieties even holding their fruit on the trees until summer. Shipments are usually heavy during December, and in the past approximately 50 per cent of the crop has been shipped before Christmas. In fact, there has been a strong tendency to begin moving the fruit before it has reached full maturity. This practice has been stimulated because it frequently happens that these early shipments give satisfactory returns, and fruit moved at this time runs no risk of being frozen later in the season. The practice of placing on the market large quantities of green fruit of poor eating quality is very objectionable, however, and does not stimulate future consumption of the product.

During the past few years the tendency has been toward lengthening the marketing season. Instead of attempting to dispose of the bulk of the crop before the holidays, when a large proportion of the fruit has not reached full quality, the season has gradually been extended, so that Florida citrus fruits are now moved in large quantities until the first of April, and even later. The influence of these changed conditions upon the occurrence of decay and deterioration at the market end will be apparent in the later discussion of the occurrence of decay at different times during the shipping season.

PICKING THE FRUIT.

Harvesting methods.—In harvesting the orange, it is necessary to sever the fruit from the trees by means of clippers or shears, the common type being a sharp-pointed clipper, such as is illustrated on the left in figure 2. Various other types are also in use at the present time, two of which are shown in figure 2.

Since many of the orange trees in Florida are large, only a small proportion of the fruit can be reached from the ground. The ordinary straight ladder, placed directly against the tree, is in common use. In order to secure all of the fruit at the top or in the center of the tree, the picker must stretch over a considerable distance, and he is very liable to pull many of the oranges which he can not conveniently sever with his clippers. Worse than this, however, it has not been uncommon to see the fruit on the ends of the limbs shaken off and allowed to drop to the ground, later to be picked up and placed in the field boxes along with the fruit properly handled.

Over the picker's shoulder is thrown a basket or bag in which the fruit is placed as clipped. The picking bag is sometimes an ordinary grain bag or gunny sack holding about 30 pounds of fruit; formerly, some men used a specially constructed bag which fastened around the body and frequently held nearly enough fruit to fill one of the boxes. The canvas-covered basket shown in Plate I, figure 1, holds approximately half of a box of fruit. Another type of picking receptacle, illustrated in Plate I, figure 2, has a hinged bottom which may be let down when emptying the fruit. The most common bag now in use is one made of heavy canvas and open at the bottom, so that the filled bag can be placed in the box and the fruit allowed to roll out gently.

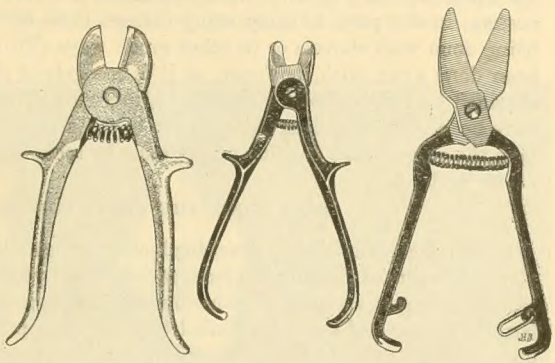

FIG. 2.—Three types of clippers used in picking Florida citrus fruits.

Field boxes.—The fruit is poured from the picking receptacle into a field crate or box. The box in general use is about 28 inches long, 12 inches wide, and 13½ inches deep, has a capacity of a little more than one packed box of fruit, and may or may not have a central partition. Both types are illustrated in Plate I, figures 1 and 2. The size of this box was established through the practice of buying large quantities of fruit on the tree at a fixed price per box. Originally this price was intended to be per "packed box," but since it is more convenient to keep the record of the fruit as it leaves the grove, this type of field box, which holds enough fruit to allow culling and still give the buyer a packed box of oranges, was developed. Other kinds of field boxes, some of which are superior to the old box, are in use to a limited extent. Plate II, figure 1, shows a type of grocer's delivery crate which some growers use for handling their oranges.

The boxes in common use are constructed of such heavy material and hold such large quantities of fruit that it is impossible to handle them with sufficient care. When loading them on the field wagon or unloading them at the packing house, or even when moving them about in the house, they oftentimes strike the floor with sufficient force to cause some of the fruit to bound out. The objection commonly raised to making boxes of lighter material is that the workmen will break them by rough handling, especially when throwing them off the wagon in the field. It is a question, however, whether the average laborer will not treat a lighter box more carefully than he will a heavy iron-bound one, which tempts him to see how roughly he can handle it.

Plate II, figure 2 shows that the effort to make a field box strong enough to withstand "bucking" is not always successful. While it is difficult to estimate the amount of damage which may result from the use of such boxes, it is apparent that this is very great.

An enumeration of some of the injuries received in picking will be found under the discussion of the causes of blue-mold decay.

HAULING THE FRUIT.

The fruit is hauled from the grove to the packing house on ordinary farm wagons, which are often springless, or on specially provided wagons belonging to an association. The owner of the grove or the manager of the packing house sometimes personally superintends this transfer, but frequently it is done by contract with the owner of a livery stable. There is usually a fixed price for this service, one large contractor receiving 2 cents per box per mile, which is about the average of what is paid in different parts of the State. The drivers are often ignorant of the importance of careful handling, and their methods of loading and unloading are extremely crude and rough. It is not uncommon to see them sitting on boxes of fruit as they ride to the packing house. The haul may be long and over rough roads (Pl. III, fig. 1), some packing houses handling many boxes of fruit from groves 12 or 15 miles distant, or even farther. Ox teams are often used for such long hauls (Pl. III, fig. 2). It has even been the custom, in the past, to carry many oranges loose in the wagon box, the unloading being done with shovels or in other rough ways (Pl. IV, fig. 1). This practice has been done away with, however, as it is recognized that good results can never be obtained by such careless methods. Along with the numerous improvements which have been effected during the past two or three years in the manner of hauling fruit from the grove to the packing house, must be reckoned the State-wide movement for better roads.

PREPARING THE FRUIT FOR SHIPMENT.

Buildings and machinery.—Packing houses are usually located in villages and towns along the railroad lines or in places accessible to water transportation. Many boxes of fruit, however, are packed either openly in the groves or in houses located near the farm buildings and are then hauled to a shipping point. Little attempt was made until recently to build houses especially designed for packing citrus fruit. The average building usually had a capacity for handling not more than one car a day, very little machinery being used in the old houses and the boxes being made by hand, frequently in some place outside the packing house. This building generally consisted of but one room, the sizing machine being located in the center, a little below the main portion of the house, in what is called the "pit." One common source of trouble, even in the new-style houses, is the attempt to save floor space. The machinery may be so adjusted that the orange has to follow a long and complicated path, around abrupt angles, down gravity runs, and up unnecessary elevators, whereas in a majority of cases the same end could have been attained at less expense by means of a more simple arrangement. Simplicity should be the watchword in the adjustment of all packing-house equipment. Some houses have gone to the other extreme of doing practically all the work by hand, thus eliminating the expense of carrying belts and other automatic devices. The character of the workmen is then of fundamental importance, and it is doubtful whether, in the long run, hand work can be accomplished with as little injury as results from the use of properly adjusted, simple machinery.

Fruit which was clean and did not require washing was formerly poured into a hopper and rolled by gravity in front of the grader to the sizing machine. The latter was sometimes run by power, but more often it was treadled by the man who did the grading. As the oranges were sized they fell into different bins and from these were

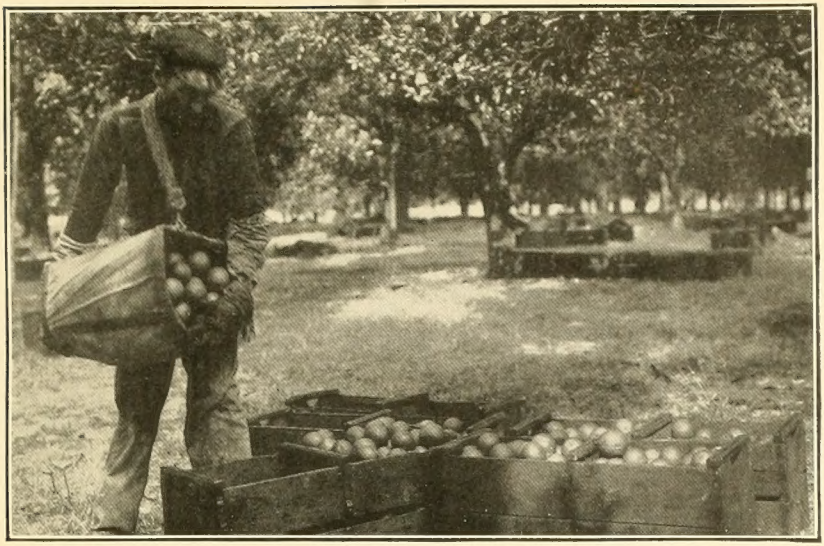

FIG. 1.—EMPTYING ORANGES FROM A PICKING BAG INTO A FIELD CRATE, SHOWING AN INCORRECT METHOD, WHICH RESULTS IN THE SERIOUS BRUISING OF THE FRUIT.

FIG. 2.—FLORIDA FIELD CRATE WITHOUT A CENTRAL PARTITION AND ONE TYPE OF SMALL PICKING RECEPTACLE OPENING AT THE BOTTOM TO AVOID BRUISING THE FRUIT BY DROPPING.

PICKING RECEPTACLES AND FIELD BOXES FOR FLORIDA CITRUS FRUITS.

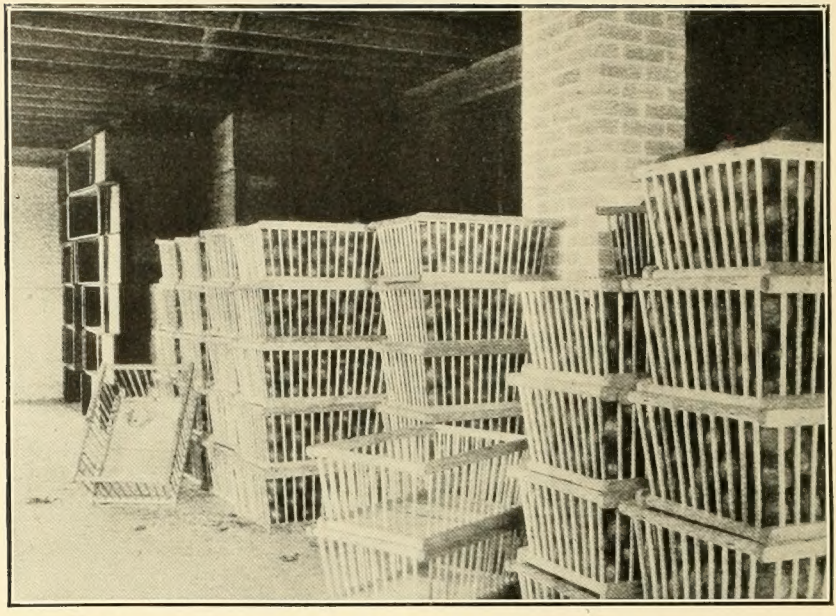

FIG. 1.—GROCERS' DELIVERY CRATES USED BY SOME GROWERS FOR HOLDING ORANGES.

This crate supplies maximum ventilation and has no sharp corners or projections to injure the fruit.

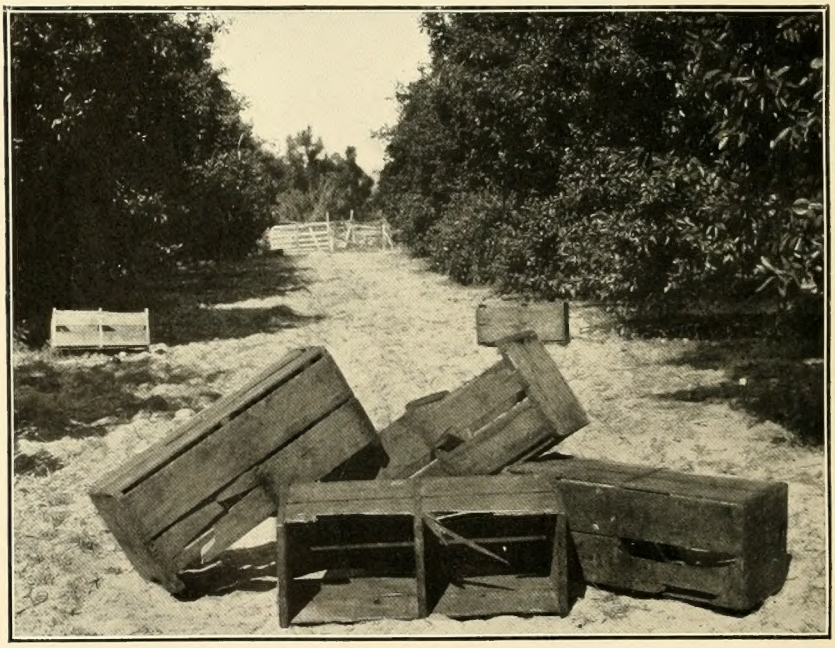

FIG. 2.—BROKEN FIELD CRATES.

The splinters, sharp edges, and projecting nails are common sources of serious injury to Florida citrus fruits.

TYPES OF FIELD BOXES FOR CITRUS FRUITS IN FLORIDA.

FIG. 1.—HAULING ORANGES OVER ROUGH ROADS ON WAGONS WITHOUT SPRINGS.
The jolting and jarring and the driver seated directly upon the fruit result in serious injury.

FIG. 2.—HAULING ORANGES BY TEAMS OF OXEN HITCHED TO SPRINGLESS WAGONS.

TRANSPORTING FRUIT FROM THE GROVE TO THE PACKING HOUSE IN FLORIDA.

FIG. 1.—GRAPEFRUIT CARRIED LOOSE IN THE BED OF A SPRINGLESS WAGON AND PILED IN THE GROVE.

Note that the wagon driver is in the act of throwing fruit from the wagon to the pile.

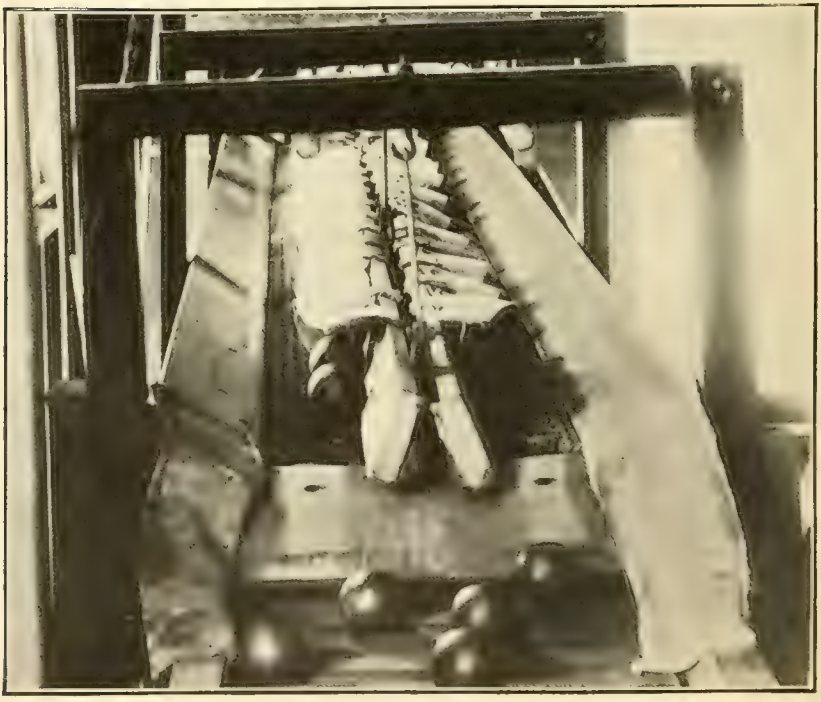

FIG. 2.—ONE TYPE OF ORANGE WASHER NOW IN USE IN FLORIDA.

packed out (Pl. V, figs. 1 and 2). In most of the houses at the present time the fruit is carried in front of the graders on canvas belts to the sizing machines, which are usually run by power. The majority of the packers now wish to ship their fruit as soon after picking as possible. Some, however, still keep it for a couple of days to wilt or "cure," as the process is called.

Cleaning.—During the past few years cleaning the fruit has become more and more necessary because of the spread of the white fly. At the present time probably 75 per cent of the Florida orange crop is cleaned either by washing or by the sawdust method. Until some method of controlling the white fly has been discovered, it will be necessary to continue these processes and even to extend them to a larger proportion of the fruit.

Various methods of washing are used, and many different types of washers are now in operation in the State. Some of the machines developed and used extensively in California have been installed, and other types have originated in Florida. The fruit is either dumped into a small hopper leading to a tank of water or is emptied directly into the water, and the cleaning process consists of passing the fruit, either while in the water or while still wet, over or between rapidly moving brushes, which remove the sooty coating from the skin (Pl. IV, fig. 2, and Pl. VI, fig. 1). A number of washers are used in which the cleansing is done by means of sponges or rags. After the fruit has been washed it is run through "artificial" forced-air blast driers or else elevated to drying racks (Pl. VI, fig. 2) and when dried is ready to be graded and sized.

Another method of cleaning citrus fruits, especially grapefruit, is with sawdust. Large horizontal cylinders are completely filled with fruit, a few pounds of wet sawdust are added, and the cylinders are then revolved for 8 or 10 minutes by hand or other power. The movement of the sawdust over the surface of the fruit rubs off much of the dirt and sooty mold. No drying is required after this process (Pl. VII, fig. 1).

Grading.—There are no set rules for grading oranges and grapefruit in Florida. As a rule, only two classes are made, "brights" and "russets," in addition to a poorer grade which is shipped to near-by markets. The bright fruit is that which is free from the effects of the work of the rust mite, a small mite which punctures the oil cells in the skin of the fruit, causing the surface to become brownish in appearance. The russet grade is composed of fruit more or less affected by the work of the rust mite. Fruit affected with melanose, a disease common in many sections, is also usually placed in the russet grade. The russeting due to the work of the rust mites is quite characteristic of the Florida orange and has been almost a trade-mark for the fruit, the general impression prevailing in the North that such oranges are a distinct variety grown only in Florida. Consequently, this grade frequently brings as much money as bright fruit. It has never been determined that the work of the rust mites affects the quality of an orange or grapefruit. The number of mites varies considerably in different localities and even in groves in the same locality, and when present they may be largely controlled by the use of sulphur sprays or by dry sulphur blown upon the trees.

A few packing houses in the State make more than two grades. The finest of the bright fruit may be packed as "fancy," or some of the brightest russets may be labeled "golden." There are no uniform rules in the State, however, and similar grades of fruit from different packing houses may be sold under different names. Moreover, all grading is without reference to the size of the fruit. As one man grades a car or more of fruit each day, the work can not be done very thoroughly. There is a strong tendency at present to establish more definite grades and to secure better methods of grading (Pl. VII, fig. 2).

The sizes of Florida oranges vary from 80 to 420 fruits in a box, some fruit occasionally falling outside even these wide limits. The common sizes are 126, 150, 176,

and 200 oranges to a box. When only two grades of fruit are made, a double sizing machine is commonly used, and both grades are sized at the same time (Pl. VIII, figs. 1 and 2).

The Florida grapefruits are packed with 28, 36, 46, 54, 64, 72, 80, or 96 fruits to the box, the most desirable sizes being 46, 54, and 64. The "Standards" vary from 54 to 80. Fruits packed 46 to the box and larger are known as "large off sizes," grapefruit being occasionally offered as large as 18 to the pack. This is more of a novelty than a commercial proposition, however. The "small off sizes" are those packed 96 to the box and smaller. Some of the regular orange-sizing machines can be adjusted for the sizing of grapefruit, but few of them are wholly satisfactory, on account of the variation in shape of the fruit.

Packing.—Many houses now employ girls and women as packers, although formerly the work was done almost exclusively by men, who were usually paid by the day. High-grade work is done on the average, and considerable care is taken to have each orange put in its place with a little pressure. This makes a firm pack and one which is smooth and of good appearance. The box is filled an inch or more above the top, and when the cover is put on pressure is used to bring the fruit at the ends even with the top of the box. A few shippers fill their boxes much higher than this, thereby making necessary considerable pressure in order to nail on the cover. This type of package, known as the "bulge pack," was developed to meet the buyers' demands for a full box of fruit on arrival in market. High packing is often an excuse for poor packing, however, since oranges which are laid in the box loosely and without pressure must be forced into place when the cover is nailed on, thereby increasing the liability of crushing the fruit in the top layers. A pack which is of medium height, with every orange firmly in place, is less liable to be injured in transit than is a high, loose pack, and the fruit will arrive in market with a more attractive appearance and will remain in good condition for a longer period.

The "nailer" takes the box after it is packed, and holding the cover across the fruit with both hands, he gives the box two or three sharp jolts upon the floor, first at one end, then at the other, before nailing it fast. Box presses are in use in a number of houses in the State. Whether the nailing is done by hand or with the aid of a press, care should be exercised to avoid injuring the contents of the top layer against the sides and ends of the box. Some pressmen have the habit of adjusting the covers after pressure has been applied by tapping the ends of the slats, but this scratches or rasps the fruit on top and serious injury sometimes results. The beveled ends, sides, and center pieces which are coming into general use are of great value in preventing injuries during the nailing operation.

The Florida shipping box for both oranges and grapefruit measures 12 by 12 by 27 inches, inside dimensions, and has an estimated weight of 80 pounds when filled. It is made with paneled heads, has sides of veneer in one piece, and is bound with three straps of birch or other wood. Wire hoops are now used extensively in place of the wooden straps. This makes a strong package, suitable for long-distance shipments.

Shipping.—More attention than formerly is now being given to loading the fruit in the cars. It has been the custom to stack the boxes loosely in the cars, those in the lower tier standing on end and the rest placed lengthwise on top. On account of the strength of the box and the comparatively short haul, the loading is done rather carelessly, very little bracing being used, and often none at all. Although it is not common for the boxes to reach the market in a broken condition, considerable injury in transit is liable with a load of this kind. The better method now coming into general use in Florida is to stack the boxes two tiers high on end, using a car strip across each row and bracing the load securely in the middle. This insures a minimum of broken boxes or other injury on arrival in market.

FIG. 1.—EXTREME TYPE OF LARGE HOPPER FORMERLY IN USE, THE SIZE BEING INDICATED BY THE SIZE OF THE MOWING MACHINE AT THE RIGHT.

The fruit is emptied from outside through trap doors in the background, a wagonload at a time. Serious injury is caused by bruising and by the twigs and other débris accumulating on the floor of the hopper.

FIG. 2.—ANTIQUATED MACHINERY FOR GRADING AND SIZING THE FRUIT.

Note that the sizing machine is being treadled by the grader. Note also the large hopper at the rear.

INTERIOR VIEWS OF OLD ORANGE-PACKING HOUSES IN FLORIDA.

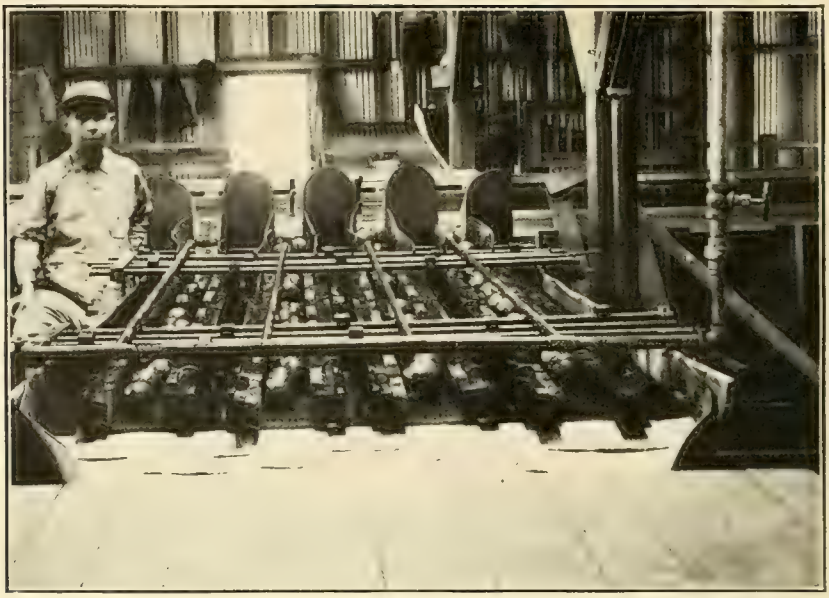

FIG. 1.—ONE TYPE OF ORANGE-WASHING MACHINE USED IN FLORIDA.

The fruit is always in sight as it passes through the machine.

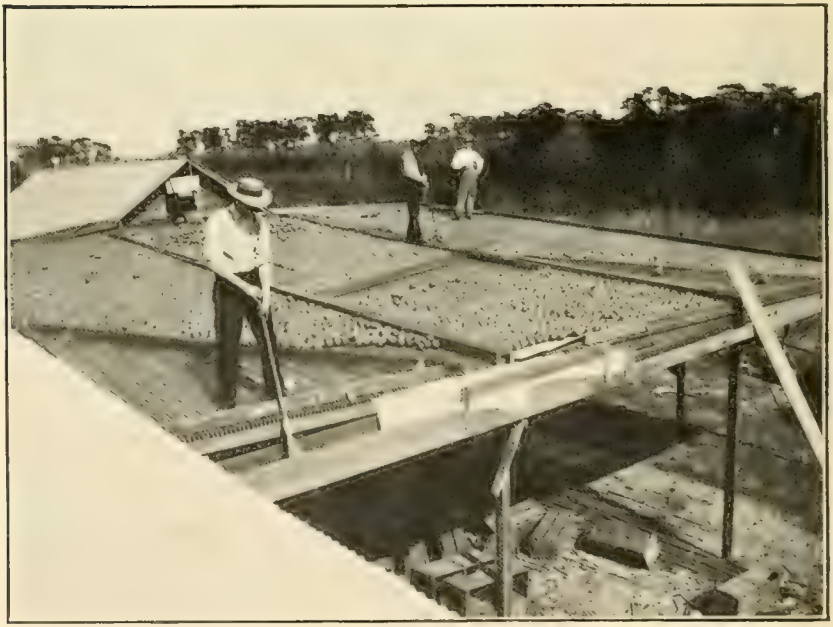

FIG. 2.—DRYING FLORIDA ORANGES IN THE SUN.

Serious injury follows the use of unprotected brooms, and bruising from rolling over and dropping through steep gravity runs.

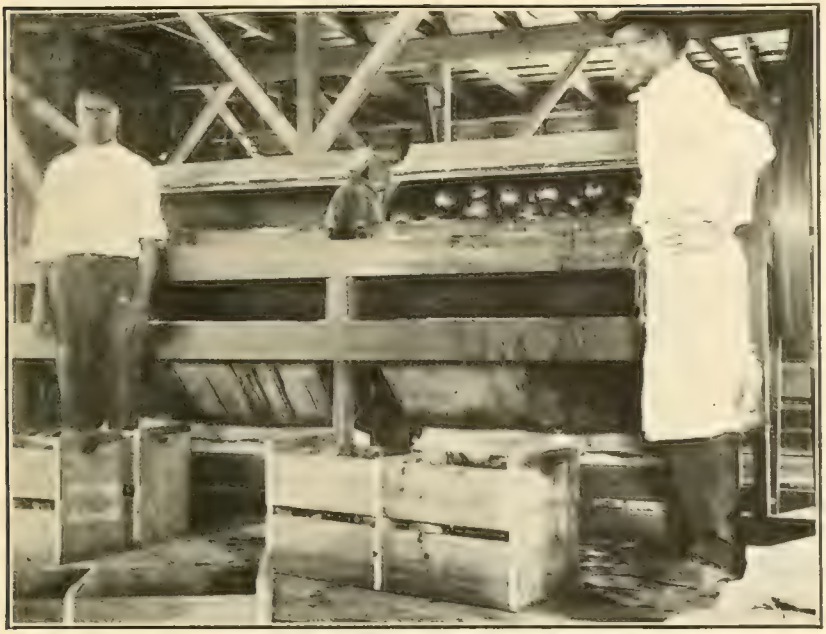

FIG. 1.—A SAWDUST CLEANER FILLED WITH GRAPEFRUIT.

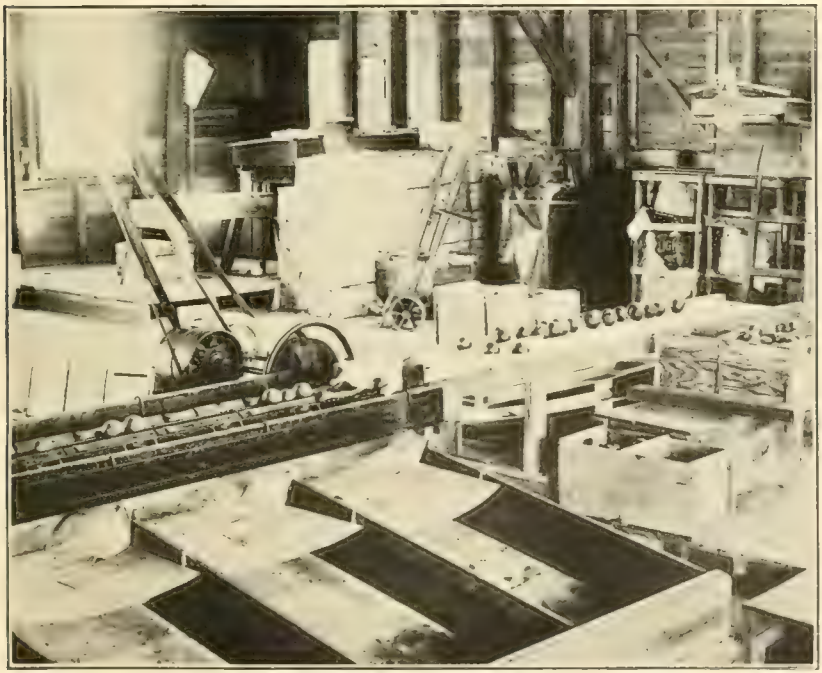

FIG. 2.—GRADING BELT BUILT BY THE BUREAU WORKERS FOR EXPERIMENTAL PURPOSES TO REPLACE THE LARGE HOPPER SHOWN IN PLATE V, FIGURE 1.

FIG. 1.—TYPE OF ORANGE SIZER, HOPPER, AND BINS USED IN THE OLD PACKING HOUSES IN FLORIDA.

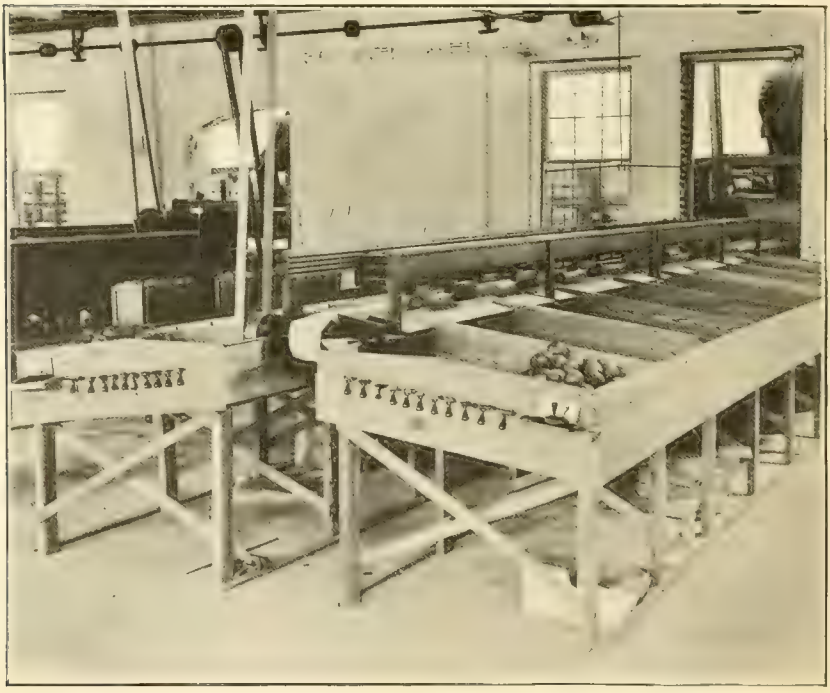

FIG. 2.—ONE TYPE OF SIZING MACHINE IN A MODERN PACKING HOUSE IN FLORIDA.

ORANGE-SIZING MACHINES.

The length of time in transit from central Florida to Philadelphia or New York varies from four days to more than a week. There are several routes by which fruit may be shipped to northern points. It may go "all rail" by freight, either in carloads or by local freight. Small consignments are sent by express to Savannah and from there by freight to their various destinations, and some fruit is shipped by water from both Jacksonville and Savannah. The rates to northern points vary somewhat by these different routes. Jacksonville is the basing point, and the "all rail" freight rate thence to Baltimore is 43 cents per box in carload lots. This rate to New York is 46 cents, to Boston 51 cents, to Pittsburgh 52 cents, and to Chicago 53 cents. The water rate from Jacksonville is 35 cents to New York and 40 cents to Boston. In less than carload lots the "all rail" freight rate to Baltimore is 47½ cents, to Boston 59 cents, and to Chicago 97.2 cents. These rates apply on shipments moving through Jacksonville for points beyond. The rate is higher when the fruit is shipped to Jacksonville, the freight charges paid there, and the shipments rebilled to points beyond. In addition to the above charges the shipper has to pay the local freight from his shipping station to Jacksonville. This local freight rate per box is 15 cents from Orlando, 20 cents from Arcadia, and 26 cents from Miami.

During 1912–13 there were 321 boxes in the average carload. A few men shipped 400 or more boxes per car, but this practice should be discouraged. Such heavy loading leaves no space in which the air may circulate and affords a splendid opportunity for the development of decay in transit. The Florida car is smaller than the one used by the California shippers and should contain not more than 360 boxes. The inside measurements of the standard shipping car for oranges are 33 feet in length, 8 feet in width, and 84½ inches in height. The minimum freight weight of a standard car of 300 boxes is therefore 24,000 pounds, reckoning each box at the arbitrary weight of 80 pounds. The freight rate is assessed per box, the average rate on citrus fruits shipped from Florida during 1912–13 being 65.7 cents per box of 80 pounds' weight. A car of oranges may contain boxes of oranges of all sizes, the fruit being generally loaded in the cars "orchard run," although some purchasers specify in advance the sizes desired.

Refrigeration and ventilation.—Prior to the season of 1912–13, nearly all of the shipments of Florida citrus fruits were handled under ventilation. A few of the late oranges, especially Valencias, have been shipped under refrigeration during the latter part of the season when the weather was warm either in Florida or while the fruit was in transit, but it is estimated that not more than 1 per cent of the shipments of citrus fruits were iced in any season previous to 1912. The conditions surrounding the citrus-fruit industry of Florida have been largely responsible for the lack of the proper facilities for the shipment of oranges under ice. Before the reorganization of the industry, following the introduction of modern handling and packing facilities, there was little or no opportunity to utilize refrigeration in transporting the citrus crop to market. A large proportion of the fruit was handled in local consignments to central points, such as Jacksonville, Fla., or Savannah, Ga., and at these gateway cities carload shipments were made up. In some instances the fruit was sent by boat to Jacksonville or Savannah and thence forwarded north by railroad. During the past three or four years this practice has changed to a very great extent, and at the present time only a small proportion (if any) of the shipments of Florida citrus fruits are assembled after local shipment at the central points mentioned. Packing houses equipped with modern appliances have been erected throughout the State. Full carloads are now made up at these houses and the fruit is shipped north direct from the point of production or packing. The opportunities for utilizing refrigeration have thus been increased, as the fruit can now be loaded direct into iced cars instead of being first shipped locally in unprotected "ventilator" or box cars.

The prevailing opinion among fruit growers and shippers formerly has been that Florida citrus fruits do not need refrigeration. Practically the entire crop is moved

during the winter and early spring months, when the prevailing outdoor temperature is low, so low at times that the problem has been to protect the fruit from freezing rather than to reduce its temperature by artificial means. During periods of extremely cold weather refrigeration may be a distinct disadvantage rather than otherwise. With the present refrigerator-car equipment, the insulation provided to keep the fruit cool during transit must also be relied upon to protect the fruit from freezing. This it does by retarding the cooling of the fruit and reducing its temperature very slowly, thus enabling the car to reach the market before the contents are actually frozen. It is easy to see that the length of time required to cool the fruit to an injurious extent depends upon (1) the outdoor temperature, (2) the efficiency of the insulation of the car, and (3) the temperature of the fruit at the time the car encounters extreme weather conditions in the North.

The present-day refrigerator car is only partially efficient during extreme weather. There are many types of refrigerator cars with varying insulation, but none are able to withstand extreme cold for any considerable length of time without the use of artificial heat, just as they are unable to keep the contents cool in hot weather without the use of ice. It follows, then, that under ordinary conditions during cold weather fruit which has been cooled by the use of ice during the early part of the trip from Florida will be more liable to injury from freezing than fruit which has not been so cooled before it is subjected to extremely cold weather. The appreciation of this point is of great importance in discussing the refrigeration of Florida oranges, because a very large proportion of the crop is moved during periods of excessively cold weather in the North, although the temperature in Florida may be sufficiently high to warrant the use of ice at the beginning of the trip.

The investigations of the Bureau of Plant Industry have amply demonstrated that Florida oranges may be transported to market under ventilation with a minimum loss from decay, even during periods of warm and humid weather, if sufficient care is used to preserve the skin of the fruit in a sound, unbroken condition. None of the experimental shipments commented upon in this paper were refrigerated. The use of refrigeration during transit to market must not be considered as a means to offset the effects of rough or careless methods of handling. Icing can not permanently prevent deterioration. The low temperature only temporarily arrests the development of the decay fungi. As soon as the fruit has been unloaded in market it warms up, and decay develops very rapidly if a considerable number of the oranges have been injured by careless handling. As a result such fruit soon gains a reputation for very poor market-holding qualities. It is as important to have the fruit reach the consumer in good condition as it is to have it arrive in the market sound.

A considerable number of shipments were iced during the season of 1912–13, especially during January and during a later period of warm, humid weather, when heavy decay developed in nearly all shipments. It is safe to say that the number of cars handled under refrigeration during this season was greater than during all previous seasons together. Many of the shippers claim that they have been able to place the fruit on the market in much better condition when shipped under refrigeration than when shipped under ventilation only. This conclusion is based upon a comparison of iced and noniced shipments. It is probable, however, that the comparison was not always fair, for the reason that no systematic study was made of the behavior of fruit of the same grade and quality under the two systems of shipment. Nevertheless, the general opinion prevails among growers and shippers that icing has resulted in material benefit to the fruit and has yielded increased returns. Refrigeration, therefore, bids fair to become an important factor in the handling and shipment of the Florida citrus crop.

During the past season, with its periods of excessively high decay, the Florida Citrus Exchange strongly urged its members to move their fruit north under refrigeration. The recommendations of the exchange officials, in brief, provided (1) that the

ice should be put in the tanks 24 hours before loading the fruit, and preferably 48 hours previous, in order to properly cool the cars; (2) that the boxes of oranges should be stacked near to the car and when the doors were opened the loading should commence immediately and not consume more than one hour; (3) that the doors should then be tightly closed and the car moved forward immediately. Since the refrigerating rates are per car and not per box, some growers loaded the cars very heavily this past season, shipping 400 or 500 boxes per car, in order to reduce the refrigerating charge per box. This left no room for ventilation or circulation of air, and as a result decay was heavy, especially in the top tiers. Boxes should not be loaded more than 2 tiers high and no car should contain more than 360 boxes. These may be loaded 6 rows across, 30 boxes long and 2 tiers high, on end.

Many refrigerator cars were shipped under one-half icing during 1912–13. When the fruit was very soft or from groves known to be diseased, full icing was found to be necessary. Table I gives the refrigerating rates for half icing from Florida to various points throughout the United States, these being in addition to the regular rates for transportation. When the entire ice bunker is filled, the charges are increased 50 per cent above those for half-bunker icing. For example, when the half-bunker rate to New York is $50 per car, the full-bunker rate is $75.

TABLE I.—*Rates per car for half icing from Florida to points in the United States, season of 1912–13.*

To southern points.		To eastern points.		To northern and western points.	
In State of—	Rate.	From Jacksonville.	Rate.	In State of—	Rate.
Georgia	$35.00	Taking rate of		Ohio	$50.00
Alabama	40.00	43 cents per box	$45.00	Indiana	50.00
Tennessee (except to Chattanooga)	45.00	44 cents per box	45.00	Michigan	55.00
To Chattanooga	40.00	46 cents per box	50.00	Illinois	50.00
Kentucky	45.00	48 cents per box	45.00	Wisconsin	55.00
Mississippi	45.00	50 cents per box	50.00	Missouri	55.00
Texas	62.50	51 cents per box	55.00	Nebraska	55.00
South Carolina	35.00	52 cents per box	50.00	Kansas	55.00
North Carolina	35.00	53 cents per box	55.00	Colorado	62.50
Virginia (as to Lynchburg, Norfolk, Richmond, Roanoke, and Portsmouth)	45.00	55 cents per box or higher	55.00	Minnesota	55.00
				Iowa	55.00

MARKETING THE FRUIT.

Noncooperative buyers.—Most of the Florida citrus fruits have been handled on the market by fruit buyers and speculators. Large quantities have been bought on the trees, either in bulk or at a fixed price per box, by local buyers who own packing houses in near-by towns. There are many such buyers, and, although very few of them are growers, they purchase enough fruit each year to pack and ship thousands of boxes. The largest part of the Florida citrus crop has been handled in this manner in recent years, the picking and hauling being done under the direction and at the expense of the buyers. These men have regular customers to whom they make shipments, and they also consign large quantities of fruit to commission houses. If a grower desires to pack his own fruit, he may be able to sell it before shipping it, but usually he consigns the cars to a commission man whose agent has solicited his trade. If the grower is doing business with a reliable firm, the success of this method depends largely upon having a good grade of fruit which is packed in an attractive manner and reaches the market in sound condition. Since most of the commission houses operating in Florida are located in the larger northern and eastern cities, the heavy shipments of fruit to these points often cause the market to be glutted with Florida oranges.

Several large selling agencies are now operating in Florida and are handling much of the citrus fruit. These firms may or may not be directly concerned with the grading and packing of the fruit. Although in a few instances they control this portion of the work almost entirely, and so are able to offer for sale large quantities of fruit of a rather uniform grade, their primary aim is to handle for the packers all matters pertaining to the sale of the crop. They claim to be able to keep a closer watch on the markets and on general trade conditions than an individual grower or packer can possibly do, and, by means of competent sales agents throughout the country, to be able to control the distribution of the product so as to avoid gluts and the resultant low prices. Their selling charge may be a flat rate per box, but more often the business is conducted on a percentage basis.

Florida Citrus Exchange.—The movement for cooperative marketing, begun during the season of 1909–10, gained considerable headway among the citrus fruit growers of the State and resulted in the formation of the Florida Citrus Exchange. The organization was modeled after the California Fruit Growers' Exchange, which has been successfully packing and marketing a large percentage of the citrus fruits of California for a number of years. During its first season (1909–10) the Florida Citrus Exchange handled more than 1,000,000 boxes of fruit.

The Florida Citrus Exchange is composed of a number of cooperative associations throughout the State. These are made up of individual growers who form a corporation, build a packing house, elect a manager, determine the grades under which their fruit is to be shipped, and attend to all the business directly connected with the harvesting, packing, and shipping of the fruit. The cooperative packing houses located in any one of the several citrus districts of the State unite to form a subexchange, whose manager has charge of the larger business interests of the houses in his district, keeping in close touch with the central offices of the exchange, and advising with them regarding the qualities and grades of fruit in the various cars shipped, the methods of packing employed, and all other matters regarding which a selling agency should be well informed. A union of the various subexchanges forms the Florida Citrus Exchange, which has its headquarters at Tampa. This is an incorporated body, with a board of directors and officers for carrying on the business of marketing the product. Representatives of the exchange, who are paid on a salary basis, are located in the various trade centers and have charge of the sale of the fruit.

The fruit of the individual grower may be handled in the packing house as a separate account; or it may be packed under certain grades, a record being kept of the number of boxes of each grade made from the fruit of that grower, whose identity is lost as soon as this amount has been recorded. When the latter plan is followed, the season is generally divided into periods of several weeks in length, called pools, the receipts for all fruit shipped during each period being averaged by grades. The individual grower receives a pro rata share of the proceeds, determined by the quantity of each grade of fruit which he has delivered at the packing house during that pool. In a few packing houses one pooling period extends over the whole season, and the only average made is based upon the proceeds of the entire crop.

KEEPING QUALITY OF FLORIDA ORANGES.

The keeping quality of the orange is naturally good. Since the life processes of the fruit continue after it has been severed from the branch, there is a prolonged period during which an uninjured orange remains sound and free from all decay. Ultimately, when the life span has been run, the tissues die and decay follows even in uninjured fruits. The delay is long enough, however, to allow the average fruit to be packed and placed on the market and to reach the consumer in sound condition.

HEAVY LOSSES FROM DECAY IN COMMERCIAL SHIPMENTS.

The losses from decay during transit have been very heavy in the commercial shipments of fruit, and the experimental work of the Bureau of Plant Industry was undertaken in Florida in response to the many requests for advice and assistance which came to the Department of Agriculture. It is difficult to estimate what the actual loss from this cause has been during past seasons. Several reliable commission men who handle large quantities of Florida oranges each year have stated that averaging the good with the bad years probably 10 per cent of the fruit decayed before reaching the consumer. Experimental shipments made under the direction of this bureau indicate that the loss may have been fully as heavy as this.

Since Florida's orange crop averages 4,000,000 or 5,000,000 boxes per year, the decay of 8 or 10 per cent of this fruit entails an annual financial loss of at least half a million dollars. Ten per cent of 4,000,000 boxes amounts to 400,000 boxes, on which the picking and packing charges have been paid, with approximately $50,000 spent for box material alone. The freight charges represent something like $200,000; and these amounts, together with the commission charges, the value of the fruit discarded, and the cost of repacking what is left, bring the total loss high enough to seriously endanger the welfare of the industry.

REPUTATION INJURED BY DECAY IN TRANSIT.

Unfortunately, the financial injury is not confined to the fruit actually decayed. It is impossible to estimate the loss which has resulted to the industry from the bad reputation which Florida fruits have gained in the trade. While it is difficult to discover how far the low prices occasionally received have been due to this cause, many fruit handlers in northern markets condemn very strongly the poor keeping quality of the Florida orange and willingly admit their intention of using fruit of better keeping quality if they can obtain such from other points. The situation of the Florida orange grower would be critical indeed if it were not for the fact that fruit handled carefully shows so much less decay than does fruit picked and packed under careless commercial conditions.

HISTORY OF THE DEPARTMENT WORK IN FLORIDA.

Investigations by the Department of Agriculture, having in view the discovery of the factors underlying the successful shipment of oranges from Florida to northern markets, began during the season of 1907. The work, which was planned along lines similar to those followed in the California investigations, included the determination of the character and type of handling employed in the various operations of preparing fruit for shipment and the discovery of the relationship between present methods and the occurrence of decay. The object of the work of the department was to suggest changes in the industry which should reduce the immense annual financial losses of the Florida growers by enabling them to market their fruit in sound condition.

The first researches in Florida were conducted by Mr. L. S. Tenny, who devoted his attention to an inspection of the work done by various picking crews and individual pickers, as well as to the character of work being done in the packing houses. It required only a short time to indicate that what had previously been found to be the case in California was also true in Florida, viz, that the fruit was receiving considerable injury in the course of its preparation for shipment. Conditions were, if anything, somewhat more exaggerated, owing to the fact that the thin-skinned, juicy Florida orange is of a more tender type and is more easily injured than the bulk of the oranges grown in California. It is safe to say that the kind of handling which would enable the California orange to go through the various picking and packing operations without injury is not safe for the Florida product. The importance of avoiding dropping or puncturing by long stems is most urgent when dealing with

thin-skinned, juicy fruit. The necessity of handling with extreme care so perishable a product as the Florida orange can not be too strongly emphasized.

After the determination of the character of work being done and the discovery that considerable injury was being inflicted on Florida fruit, the investigations were so planned as to determine whether it was practicable to handle the fruit with sufficient care to prevent injury. At first demonstrations corresponding to those carried on in California were made in the packing houses, using fruit selected for soundness and similar lots showing injuries of various kinds. The effects of dropping the fruit and of washing it to remove sooty mold were also demonstrated. These lines of work proved conclusively that blue mold develops wherever the skin of the orange is injured in any way, and that dropping is followed by serious decay, especially when the fruit falls into a receptacle containing dry twigs, gravel, splinters, or other matter rough enough to bruise or puncture the skin.

After the packing-house demonstrations, showing that sound, uninjured Florida oranges are not affected with blue-mold decay, shipping experiments under commercial conditions were undertaken. These experiments consisted of forwarding boxes of fruit of known history to Washington, where the percentages of decay were carefully determined on the day of arrival and after one, two, and three weeks, the fruit meantime being held under ordinary open-market conditions.

These experiments were followed during five successive seasons, thus enabling the investigators to determine the effect of seasonal influences. The data obtained during 1910–11 and 1911–12, when the work was undertaken on a more extensive scale than in the former seasons, corroborated the early results without exception, and the carrying quality of the Florida orange when packed and shipped in sound condition was proved to be as good as that of the California product. An injured orange, whether grown in California or in Florida, will decay whenever the conditions for the development of blue mold are favorable. A sound orange in good, healthy condition, whether grown in California or in Florida, is able to resist blue-mold decay.

BLUE-MOLD DECAY OF THE ORANGE.

Indications of decay.—The characteristic appearance of the orange decayed by blue mold is too well known to need description. Every handler of citrus fruits knows blue mold, which is by far the most common form of decay. The grower frequently sees it in the oranges hanging upon the trees, when the fruit has split or has been injured by thorns or twigs. He finds it in the fruit which has dropped to the ground. The packer sees it in the cull pile or in the boxes of fruit left standing in the house for a few days. The receiver of the fruit finds the decay as the boxes are opened, and frequently he smells it before removing the covers.

The first indication of decay is a small area of soft tissue at some point on the surface of the fruit. This increases rapidly in extent if the weather is moist and warm, and within a day or two a bluish or greenish spot develops. If weather conditions continue favorable, the entire fruit is rotted within a few days, and the surface is generally coated with a bluish or greenish blue mat or powdery covering.

BLUE-MOLD FUNGUS.

Blue-mold decay is caused by the growth of a minute organism within the tissues of the fruit. Laboratory experiments have shown this organism to be a fungus of the genus Penicillium, which includes the familiar blue mold or mildew on bread, on the surface of canned fruit, and on other vegetable matter. Growth takes place within the orange, the bluish mat on the skin being composed of the fruiting bodies made up of chains of spores, massed together in great numbers. The fungus is spread by means of these spores, which, like the seeds of many higher plants, germinate and grow as soon as they find lodgment under conditions favorable for their development. They

require heat and moisture, and when these are present growth proceeds at a very rapid rate. The blue-mold fungus has not the power to penetrate the sound living tissue of a well-grown fruit; hence, there must be a break or an abrasion of some kind in the skin, through which the disease may find an entrance. When growth has once started, even in a small way, the fungus is capable of killing the surrounding tissues and thus producing material on which to grow. This process continues until the entire fruit is destroyed. If, therefore, a fungous spore is present and lodges in an injured spot, the initial step toward decay has been taken, and if the temperature and moisture conditions during the next few days are favorable, the development of the fungus proceeds rapidly and the orange is almost sure to rot. Many experiments have been made in California and Florida packing houses in placing spores on fresh injuries, and, without exception, the characteristic decay has resulted. On the other hand, large quantities of fruit have been held under weather conditions most favorable to the development of decay, and the results prove that fruit which has been so carefully handled as to preserve the skin in an uninjured condition shows practically no decay even when the surface has been purposely covered with spores. The development of decay is most rapid during warm, moist weather, fruit packed during a cool, dry period frequently reaching the market without much waste even though injuries are present. Under changed atmospheric conditions, the same fruit may arrive in a badly decayed condition. During an average Florida winter there are usually periodical warm spells. Reports of general heavy decay at the market end can almost without exception be traced to fruit packed and shipped during these warm periods.

With this understanding of the nature and cause of the most common form of decay, it becomes easy to see how the harvesting and handling methods may have an important bearing on the keeping quality of the fruit. If these are such as to break the skin or injure the orange, even slightly, favorable conditions for the development of blue-mold decay exist and such decay is almost certain to result, as observation has shown that the spores of the blue mold are present practically everywhere. It is safe to say that most of the decay occurring in Florida oranges while in transit is due to blue mold. There is some loss in transit from decay due to other forms of rot, but this is usually very slight as compared with the loss from blue mold.

CAUSES OF BLUE-MOLD DECAY.

Since the principal means of securing oranges of good keeping quality is by eliminating mechanical injuries to the fruit, the occurrence of decay is therefore closely connected with the handling methods in use in the grove and packing house.

Thorn punctures, which are made while the fruit is still on the tree, are among the first injuries to which citrus fruits are subjected. These are generally unavoidable, as during every wind storm a certain percentage of the fruit is injured by being blown against thorns. The puncturing which occurs when the fruit is being picked may be prevented, however, although it is frequently difficult to handle the oranges with sufficient care to avoid pressure against thorns or dried twigs when these are present in large numbers. Fruit is often bruised when the ladder is placed carelessly in the tree or when the sack is allowed to strike or is pressed against the branches or ladder. (Pl. IX, figs. 1 and 2.) Moreover, filling the field boxes so high that the fruit projects above the top will result in crushing the oranges when the boxes are stacked one on top of another. The oranges may be bruised on their way from the grove to the packing house by being jolted over rough roads in springless wagons. The driver of each wagon should be given a specially prepared seat and not allowed to sit upon the fruit.

Among the most common forms of injury may be mentioned scratches made by the finger nails of the pickers and packers, each of whom should be required to wear gloves. It is comparatively easy for packers, especially if their finger nails are long,

to seriously injure a large percentage of the oranges which they handle. Some packers also do a great deal of harm by dragging the oranges around in the bins and by tossing the off sizes into the neighboring bins. Abrasions due to the presence of gravel, twigs, splinters, protruding nails, or other foreign matter in the picking receptacles, field boxes, or packing bins may have far-reaching consequences.

Bruises caused by dropping the fruit in the various stages of picking or packing have been found to cause serious loss from decay. There are a number of places where oranges may be greatly damaged by dropping. First of all, the picker may toss them carelessly into his picking basket or bag. Careless pickers frequently throw the oranges into the open receptacle by means of a shove with the clippers, the fruit sometimes falling as far as 3 or 4 feet. Serious damage may also result from emptying the fruit roughly into the field box. Plate I, figure 1, shows how the bag or basket may be held too far above the box and the fruit allowed to fall too great a distance. In case the bottom of the box is covered with twigs or small pieces of dirt the injury is greater. A sack which opens only at the top and from which the fruit must be poured into the boxes is likely to cause severe damage because of the bumps to which the fruit is subjected. Usually no greater care is observed when emptying the fruit into the field box and from that into the hopper of the washer, grader, or sizing machine. The washing machine provides excellent opportunities for the infliction of mechanical injuries and for infection from dirty water. This phase of the subject will be discussed later.

Decayed fruit and trash should not be left in the boxes or allowed to accumulate on the floor and under the packing bins. The slightest breeze will scatter great quantities of blue-mold spores from these rotted oranges over all the fruit in the house. A clean, well-lighted packing house greatly diminishes decay by reducing the chances of infection. It has a beneficial influence on the workmen as well, offering a great incentive to better work. Moreover, a clean packing house is a good indication of the character of work being done throughout and indicates whether genuine efforts are being made to improve the methods of handling.

The hopper into which the fruit is emptied has always been the source of much injury to citrus fruits in Florida. In the old style of packing house, existing before the work of the Bureau of Plant Industry was begun, the hopper was frequently large enough to hold a wagonload of fruit. Few, if any, of these are now in use. Even the more desirable small hopper was constructed with such a steep gravity run that the fruit was subjected to a severe bump on reaching the bottom. In going through the machinery or over the grading table other chances for injury occurred, and the final drop into the packing bin was sure to add several bruises. The desirable hopper has padded sides and allows the fruit to be emptied gradually by means of moving belts, which carry the fruit to the washing machine or grading belt; it is not necessary for the fruit to fall by gravity at any stage of its journey.

The most serious form of injury, however, is made by the clippers in removing the fruit from the tree. These clipper cuts are not as prevalent in Florida oranges as was found to be the case in the California fruit, for the reason that the Florida oranges are round and do not have the depression at the stem end which exists in the Washington Navel. Nevertheless, enormous damage has been done to the Florida fruits either by cutting the skin near the stem end when severing them from the branch or by puncturing them with the points. It is essential to have the ends of the clippers rounded or blunted in order to eliminate the possibility of piercing the fruit.

The presence of long stems on the oranges may be reckoned as equally disastrous. For this reason, in determining the character of work being done by a picking crew or individual picker long stems are included as imperfections. A long stem is just as serious, if not more dangerous, than an orange which has been injured in some way. The latter decays, but this rot seldom affects a neighboring orange; whereas a long stem has ample opportunity to injure a number of fruits in their progress from the tree

FIG. 1.—LADDERS PLACED CARELESSLY IN THE TREE ARE VERY LIABLE TO CAUSE INJURY TO THE FRUIT.

FIG. 2.—WHEN THE FRUIT IN THE SACK IS PRESSED AGAINST THE LADDER THE EFFECT IS ALMOST CERTAIN TO BE INJURIOUS.

PICKING ORANGES.

FIG. 1.—OLD PACKING HOUSE IN FLORIDA.

Showing a water tank made of an old wine cask and a pile of field boxes 90 per cent of which were broken or splintered.

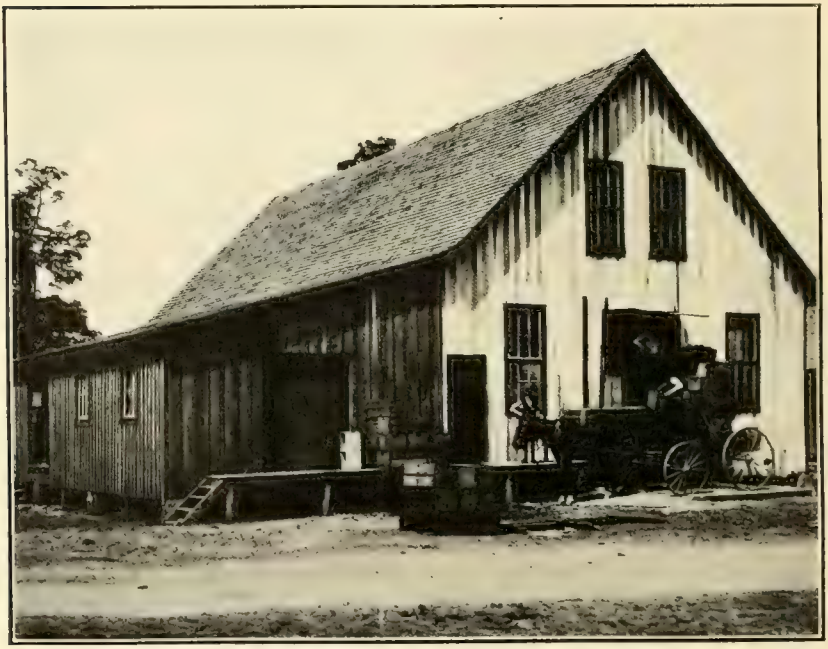

FIG. 2.—OLD PACKING HOUSE IN FLORIDA.

Showing the method of emptying the fruit into the hopper from outside.

TYPES OF OLD PACKING HOUSES IN FLORIDA.

FIG. 1.—A ONE-STORY COMMODIOUS BUILDING CONVENIENTLY ARRANGED FOR HANDLING CITRUS FRUITS.

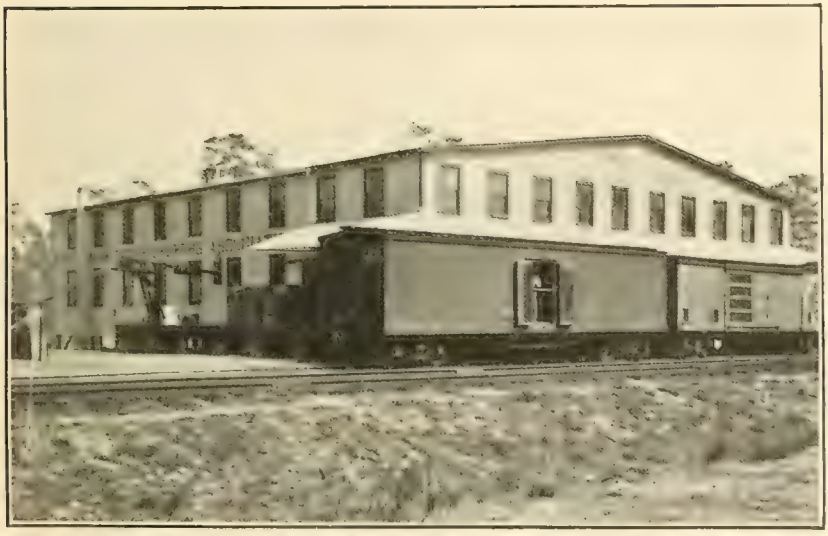

FIG. 2.—A TWO-STORY BUILDING WITH EXCELLENT FACILITIES FOR PACKING AND SHIPPING CITRUS FRUITS.

EXTERIOR VIEWS OF MODERN PACKING HOUSES IN FLORIDA.

FIG. 1.—AN OLD BUILDING FORMERLY USED FOR PACKING CITRUS FRUITS.

Note the crudeness of arrangement, the boxes of grapefruit stacked outside, and the many broken field crates

FIG. 2.—THE MODERN BUILDING WHICH HAS REPLACED THE ONE SHOWN IN FIGURE 1.

ANTIQUATED AND MODERN TYPES OF FRUIT-PACKING HOUSES IN FLORIDA.

FIG. 1.—PACKING CITRUS FRUITS IN A POORLY LIGHTED AND OVERCROWDED ROOM.

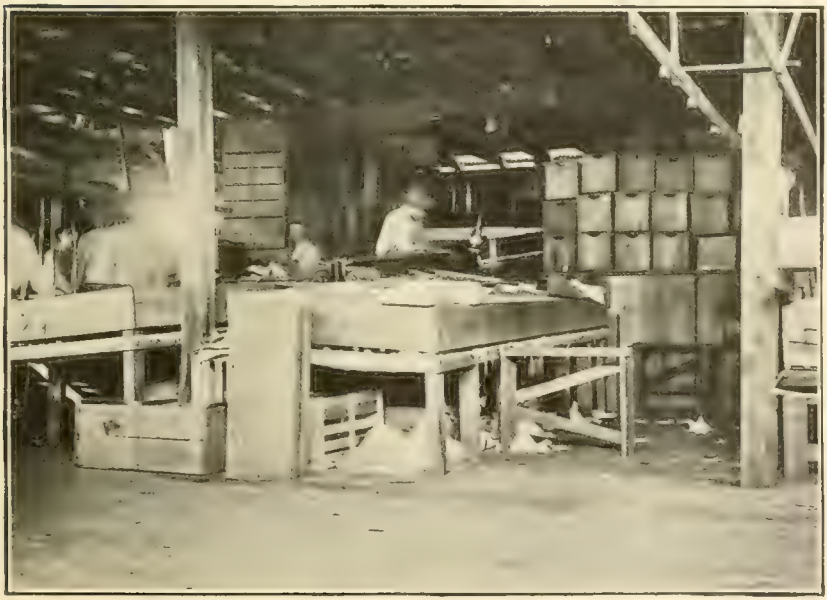

FIG. 2.—GRADING CITRUS FRUITS BY LANTERN LIGHT AT MIDDAY.

INTERIOR VIEWS OF TWO OF THE OLD PACKING HOUSES IN FLORIDA.

FIG. 1.—CORNER OF A WELL-LIGHTED BUILDING.

Showing the type of machinery used for grading citrus fruits. The interior of this building is shown in Plate XI, Figure 2.

FIG. 2.—GENERAL VIEW OF A CLEAN, WELL-ARRANGED BUILDING.

Showing new equipment for handling citrus fruits.

INTERIORS OF MODERN PACKING HOUSES IN FLORIDA.

FLORIDA ORANGE-SHIPPING EXPERIMENT, 1911.

Showing the condition of the fruit on arrival. From left to right: Careful pick and pack, commercial pick and careful pack, commercial pick and pack.

to the packing box. A sharp, ragged fragment of stem projecting from the orange will injure all the fruit with which it comes in contact in the picking bag, field box, brusher, washer, or packing bin. When it is considered that long stems are probably the most common imperfections found in the work of the Florida crews, the importance of giving particular attention to the picking becomes apparent. In most instances it is impossible to avoid leaving long stems, unless the so-called double cut is made. This means that the fruit is first severed from the tree with a stem half an inch long, which is trimmed off when the fruit is held in the hands of the picker. This enables the workman to cut closely and carefully without danger of clipper cutting, and at the same time it prevents him from throwing or "shooting" the fruit into the picking receptacle. Actual experience shows that it requires very little more time to make the double cut, and when the picker becomes accustomed to clipping in this way he can operate practically as fast as with the old method, where he has to use care to prevent clipper cutting. Of course, it takes longer to make a careful double cut than to pay no attention to the character of the work performed. Since the picker is frequently unable to see the stem when the orange is on the tree, he consumes much time in adjusting his clippers in the right position. In making the double cut he is not concerned with the placing of his clippers, simply reaching out and severing the orange with a stem long enough to avoid contact between the fruit and the clippers; then when he holds it in plain sight he can easily make a smooth, close cut.

EVOLUTION OF THE FLORIDA CITRUS INDUSTRY.

The results of the bureau investigations emphasize the importance of having the fruit arrive in market in good condition and of having it remain sound while in the hands of the wholesale and retail dealers. Shippers are frequently of the opinion that their interest in the condition of the fruit does not extend beyond the percentage of decay found on arrival. It is realized that buyers can claim allowance for such decay, and consequently shippers are usually anxious to prevent it. In their opinion any decay which results after the fruit is purchased is the buyer's loss. This impression is erroneous, for the decay which develops after the fruit is in market is just as direct a loss to the growers and shippers as that which appears during transit. Although the shipper does not have to make a cash allowance for decay occurring during the market-holding period, brands which fail to remain in good condition lose their reputation and ordinarily do not command as high prices as do those which are known for their good market-holding quality. The wholesale and retail merchants want oranges upon which they can depend to remain in sound condition. For such fruit they are willing to pay a premium, while fruit which develops a high percentage of decay before it can be sold has nothing but its cheapness to recommend it. A grower or shipper who consigns carelessly or poorly packed fruit with the expectation that it will remain sound until it gets into market deceives no one but himself. He may be able to dispose of a few cars at fair prices, but the buyers soon learn what to expect and prices fall accordingly. Fruit which develops a high percentage of decay while in the market is the poorest kind of an advertisement, not only for the brand under which it is packed, but also for the section of the State from which it is shipped.

In many cases growers and packers are anxious to do careful work, but they do not realize how many factors there are in the handling operations which may cause injury and therefore decay. They do not appreciate what careful handling means, and they underestimate its importance until the results are demonstrated to them. Injuries causing decay in citrus fruits while in transit and in market may occur from operations through which the fruit is put from the time it is taken from the tree until it is placed in the packing box. It is the prevention of these injuries in grove and

packing house that makes up careful handling, and both grower and packer are concerned in knowing how they are caused and how they may be eliminated.

At the time the department investigations were started the methods of handling Florida citrus fruits for shipment were extremely crude. Growers did their own picking, there was no uniformity of system, and the work was performed only indifferently well. These statements are not meant to reflect in any way upon the standing of the industry or to criticize the individuals who were concerned with the preparation of the fruit for market. Practically all of the imperfections were due to a lack of knowledge on the part of the growers and shippers and not to their desire to slight any of the important work. No one realized the effects of injury to the fruit, and few, if any, believed that injury was being inflicted. Growers and packers frequently greeted the department workers with the statement that practically no injury was being done to their fruit, whereas later examination often showed 15 or 20 per cent of their oranges to be injured in some way. The scattered nature of the industry was largely responsible for the crudeness with which the work was carried on. The old neighborhood competition in the production of high-grade, attractive fruit disappeared after the freeze, when the plantings were distributed so widely over central and southern Florida. Groves were more or less isolated, and a grower was frequently wholly ignorant of the type of work being done by other producers of citrus fruits.

When the department investigations were begun it seemed almost hopeless to expect that the results of the work could be made effective. The importance of getting in touch with every grower and shipper was realized from the start, yet without some central organization through which these individuals could be reached it seemed impossible to expect that improvements in the methods of handling could be inaugurated.

The changes which have taken place in Florida during the past five years are truly remarkable. The old type of packing house has almost entirely disappeared (Pl. X, figs. 1 and 2). Modern houses, equipped with the newest machinery for handling fruit properly, have been constructed in practically every citrus district in the State (Pls. XI and XII), so that at the present time the industry is particularly well provided with the mechanical appliances for doing good work. Plate XIV shows two views of clean, well-lighted, modern packing-house interiors as contrasted with the dark and crowded rooms of the old houses (Pl. XIII). The attitude of the growers and packers has changed more slowly, however. The department has conducted a large number of field demonstrations in order to educate pickers to the necessity of careful work, and although much has been accomplished in this line, as is shown by the tabulated figures given later on, much still remains to be done. The introduction of better handling methods is largely a business problem. It has to do with the reorganization of the forces of workmen and with the method of paying them rather than with the discovery of the cause of a particular form of decay.

In California the occurrence of injury in preparing the fruit for shipment was associated with the way in which the work was done. The pickers were paid by the box, and naturally each man was ambitious to pick as many boxes as possible during the day, irrespective of the character of his work. A premium was thus placed on rough handling. Several large companies, employing hundreds of men, demonstrated that by changing from the box-payment to the day-payment plan and by insisting upon careful work they could practically eliminate all picking injuries. A change in the plan of payment is not, in itself, sufficient to bring about better work, however; the workmen must be properly organized and supervised, and each individual picker must be held responsible for the character of his work. In California a change from the individual grower doing his own picking to the plan of association picking crews resulted in very great improvement in the character of the work. The same plan has more recently been carried out in Florida with very beneficial results.

INSPECTIONS OF PICKING CREWS AND FOREMEN.

Careful inspections of the work being done in different parts of the State have been made during practically every season since the work has been in progress. Table II and its accompanying diagram (fig. 3) show the average percentages of imperfections found in the work of a number of picking crews in the course of the comprehensive field inspections made by the department investigators during the seasons of 1910–11 and 1911–12.

FIG. 3.—Diagram illustrating the percentage of imperfections in the work of a number of picking crews inspected during 1910-11 and 1911-12.

TABLE II.—*Imperfections in the work of a number of picking crews inspected during 1910–11 and 1911–12.*

Class of imperfections.	1910–11[1]	1911–12[2]
	Per cent.	*Per cent.*
Clipper cuts	4.2	3.3
Long stems	12.9	18.3
Pulled	2.8	2.7

[1] Averages of 64 inspections of 51 crews. [2] Averages of 35 inspections of 34 crews.

Since the crews which were inspected were located in different sections of the State, the percentages given in the table and graphically shown in figure 3 as the averages of all inspections represent very closely the type of work being done throughout Florida; they indicate the necessity for more careful attention to the details of picking and to the organization of the picking crews. This seems the most difficult reform to bring about, yet no permanent improvement in the carrying quality of Florida oranges will be reached until the field-handling operations are completely changed.

It is also necessary to devote more attention to inspecting the work of individual pickers. Table III and its accompanying diagram (fig. 4) show the results of the

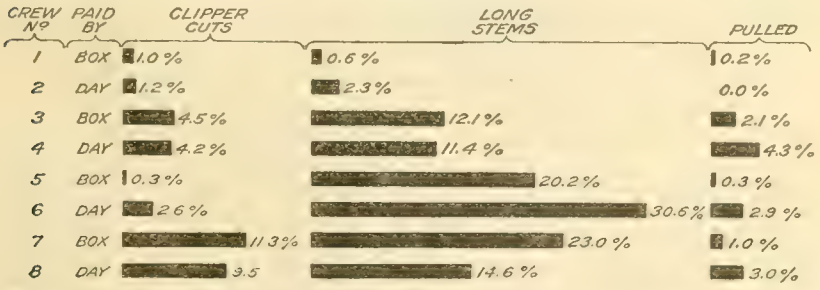

FIG. 4.—Diagram illustrating the percentage of imperfections in the work of different picking crews paid by the day and by the box, showing the variation in injury, 1910–11.

inspections of different picking crews in different parts of the State and are presented to show that good work is possible. Crews Nos. 1 and 2 were doing practically perfect work, but the work of crews Nos. 3, 4, 5, 6, 7, and 8 was far from perfect. The percentages of long stems for which these last crews were responsible ranged from 11.4 to 30.6 per cent.

TABLE III.—*Imperfections in the work of different picking crews paid by the day and by the box, showing variation in injury, 1910–11.*

Crew No.	Paid by—	Clipper cuts.	Long stems.	Pulled.
		Per cent.	*Per cent.*	*Per cent.*
1	Box	1.0	0.6	0.2
2	Day	1.2	2.3	0
3	Box	4.5	12.1	2.1
4	Day	4.2	11.4	4.3
5	Box	.3	20.2	.3
6	Day	2.6	30.6	2.9
7	Box	11.3	23.0	1.0
8	Day	9.5	14.6	3.0

The percentages shown in Table IV and its accompanying diagram (fig. 5), which were obtained from two representative crews working in different parts of the State, give the average imperfections in the work of different individuals and show how wide a variation exists in the character of work performed.

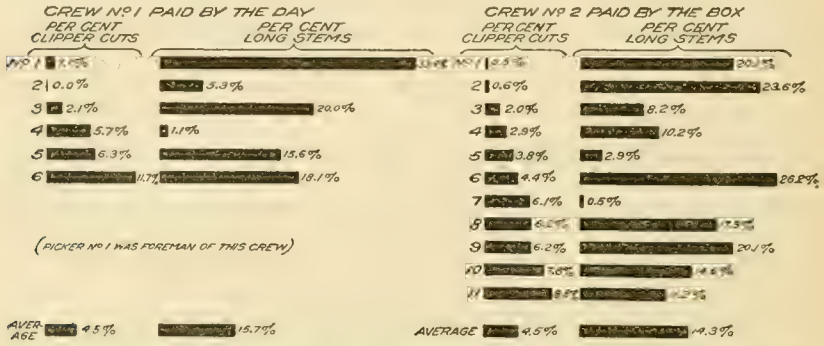

FIG. 5.—Diagram illustrating the percentage of imperfections in the work of two average picking crews, one paid by the day and one by the box, showing the variation between pickers, 1910–11.

TABLE IV.—*Imperfections in the work of two average picking crews, one paid by the day and one by the box, showing variation between pickers, 1910–11.*

Crew No. 1—paid by the day.			Crew No. 2—paid by the box.		
Picker No.	Clipper cuts.	Long stems.	Picker No.	Clipper cuts.	Long stems.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
1[1]	1.1	33.4	1	0.5	20.1
2	0	5.3	2	.6	23.6
3	2.1	20.0	3	2.0	8.2
4	5.7	1.1	4	2.9	10.2
5	6.3	15.6	5	3.8	2.9
6	11.7	18.1	6	4.4	26.2
			7	6.1	.5
			8	6.2	17.9
			9	6.2	20.1
			10	7.8	14.6
			11	8.8	11.2
Average	4.5	15.7	Average	4.5	14.3

[1] Picker No. 1 was foreman of this crew.

The figures are interesting and important because of the fact that the pickers in one crew were paid by the day while those in the other crew were paid by the box. It will be noted that there is practically no difference in the average percentages of imperfections in these two crews. In crew No. 1 the foreman was such in name only. He made no examination of the work of the men under his charge, and his own work was shown by inspection (he was picker No. 1) to be the poorest in the crew. He showed 1.1 per cent clipper cuts and 33.4 per cent long stems.

The pickers in crew No. 2, who were paid by the box, were not working with sufficient care to avoid all injury to the skin, yet the average of imperfections in the work of this crew was no greater than in the work done by crew No. 1, which was paid by the day. The simple change from the box-payment to the day-payment plan is insufficient, therefore, to bring about careful work. There must be an efficient

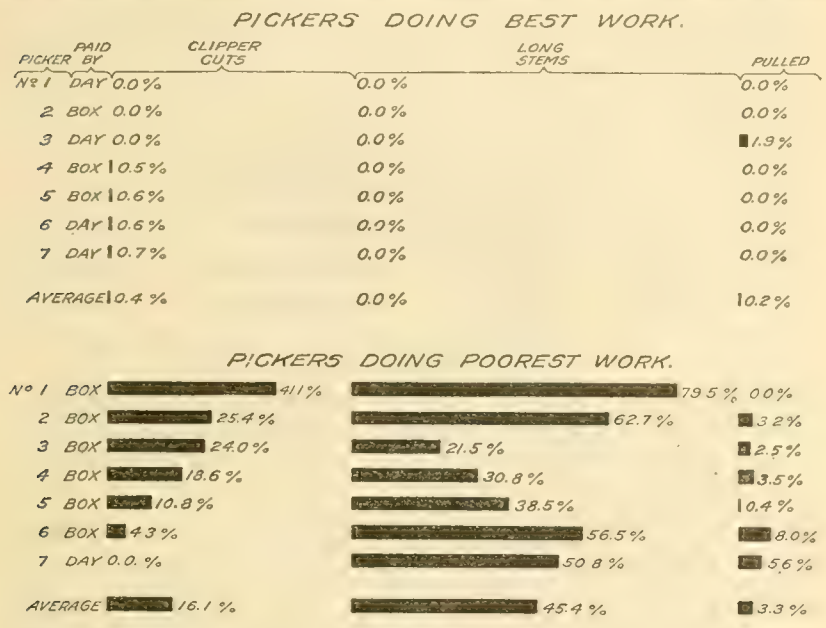
PICKERS DOING BEST WORK.
PICKER
PAID BY
CLIPPER CUTS
LONG STEMS
PULLED
No 1 DAY 0.0% 0.0% 0.0%
2 BOX 0.0% 0.0% 0.0%
3 DAY 0.0% 0.0% 1.9%
4 BOX 10.5% 0.0% 0.0%
5 BOX 10.6% 0.0% 0.0%
6 DAY 10.6% 0.0% 0.0%
7 DAY 10.7% 0.0% 0.0%
AVERAGE 10.4% 0.0% 10.2%
PICKERS DOING POOREST WORK.
No 1 BOX 41.1% 79.5% 0.0%
2 BOX 25.4% 62.7% 3.2%
3 BOX 24.0% 21.5% 2.5%
4 BOX 18.6% 30.8% 3.5%
5 BOX 10.8% 38.5% 10.4%
6 BOX 4.3% 56.5% 8.0%
7 DAY 0.0. % 50.8% 5.6%
AVERAGE 16.1% 45.4% 3.3%

FIG. 6.—Diagram illustrating the percentage of imperfections in the work of seven pickers doing the best work and seven pickers doing the poorest work, 1910–11.

field foreman whose duty it is to supervise the different pickers and who must be capable of obtaining good work from them. He should watch carefully the output of every laborer under his charge, should follow them to see what each is doing, and should insist upon careful handling. It is practically impossible for him to carry out these arduous duties if, in addition, he must pick fruit. It will be found profitable to engage a foreman solely for the purpose of supervising the crew and to insist that he give his entire attention to this work; if necessary, he should be prohibited from picking any fruit.

The variation in the work done by different individuals is further emphasized by the percentages shown in Table V and the accompanying diagram (fig. 6). The average of the best seven pickers is practically perfect, while the average of the seven pickers doing the most careless work shows a very high percentage of imperfections of various kinds.

TABLE V.—*Imperfections in the work of seven pickers doing the best work and seven pickers doing the poorest work, 1910–11.*

Seven pickers doing best work.					Seven pickers doing poorest work.				
Picker No.	Paid by—	Clipper cuts.	Long stems.	Pulled.	Picker No.	Paid by—	Clipper cuts.	Long stems.	Pulled.
		Per cent.	*Per cent.*	*Per cent.*			*Per cent.*	*Per cent.*	*Per cent.*
1	Day	0	0	0	1	Box	41.4	79.5	0
2	Box	0	0	0	2	do	25.4	62.7	3.2
3	Day	0	0	1.9	3	do	24.0	21.5	2.5
4	Box	.5	0	0	4	do	18.6	30.8	3.5
5	do	.6	0	0	5	do	10.8	38.5	.4
6	Day	.6	0	0	6	do	4.3	56.5	8.0
7	do	.7	0	0	7	Day	0	50.8	5.6
Average		.4	0	.2	Average		16.1	45.4	3.3

The importance of thoroughly inspecting the crews and of training the foremen to insist upon careful work is further emphasized by the percentages shown in Table VI and its accompanying diagram (fig. 7). These figures reveal very little difference in

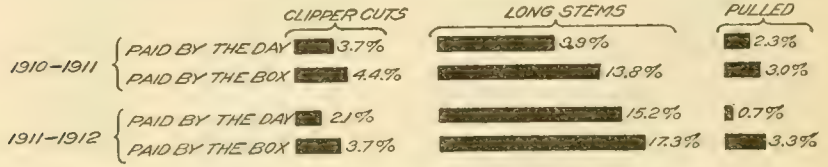

FIG. 7.—Diagram illustrating the percentage of imperfections in the work of crews paid by the day and by the box; average of all inspections, 1910–11 and 1911–12.

the averages of crews paid by the day and those paid by the box, proving that by means of careful supervision a conscientious foreman can get as good work from pickers under the box-payment plan as a more lax foreman can obtain under the day-payment plan. The efficient foreman is therefore the best solution of this problem.

TABLE VI.—*Imperfections in the work of crews paid by the day and by the box; average of all inspections, 1910–11 and 1911–12.*

Class of imperfections.	1910–11		1911–12	
	Crews paid by day.[1]	Crews paid by box.[2]	Crews paid by day.[3]	Crews paid by box.[4]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Clipper cuts	3.7	4.4	2.1	3.7
Long stems	9.9	13.8	15.2	17.3
Pulled	2.3	3.0	.7	3.3

[1] Average of 18 inspections.
[2] Average of 46 inspections.
[3] Average of 8 inspections.
[4] Average of 27 inspections.

Table VII and figure 8 show the averages of imperfections in the work of five of the best and five of the poorest picking crews inspected during 1910–11 and 1911–12.

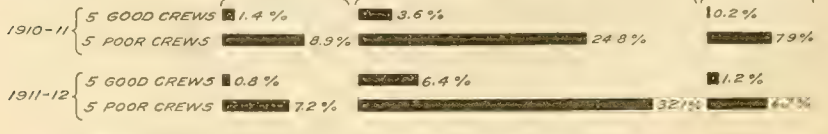

FIG. 8.—Diagram illustrating the average percentage of imperfections in the work of five picking crews doing good work as compared with five picking crews doing poor work, 1910–11 and 1911–12.

TABLE VII.—*Imperfections in the work of five picking crews doing good work as compared with five picking crews doing poor work, 1910–11 and 1911–12.*

Class of imperfections.	1910–11		1911–12	
	Five good crews.	Five poor crews.	Five good crews.	Five poor crews.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Clipper cuts	1.4	8.9	0.8	7.2
Long stems	3.6	24.8	6.4	32.1
Pulled	.2	7.9	1.2	6.7

Along with the inspections of the work of the crews and the individual pickers, an attempt was made to demonstrate the practicability of training workmen to use more care. The workers of the Bureau of Plant Industry kept in close touch with the foreman of a representative picking crew, taking pains to indicate to him the scope and character of the inspections which it was desirable for him to make. In Table VIII and figure 9 are shown the results of work of this character. The first inspection

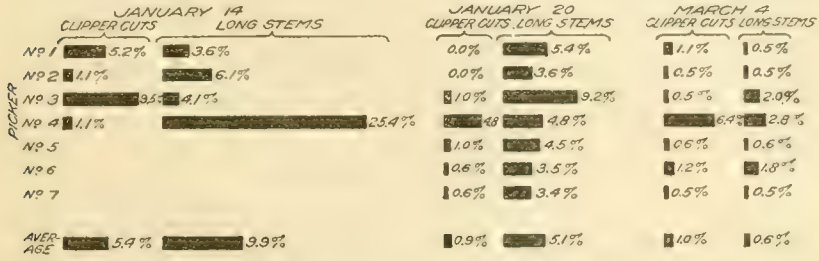

FIG. 9.—Diagram illustrating the percentage of imperfections found during three inspections of one picking crew ranging from three to seven persons, showing great improvement.

was made on January 14, when the crew consisted of four men, the average of imperfections at that time being 5.4 per cent clipper cuts and 9.9 per cent long stems. The importance of careful work was urged upon the foreman and crew, and when on January 20 a second inspection was made, a very material decrease was found in the percentages of imperfections. The crew had been increased to seven by that time, and the average of clipper cuts was 0.9 per cent and of long stems 5.1 per cent. After an additional demonstration of the effects of rough handling, no examination of the work of the crew was made until March 4, when the third and last inspection of the season was made. The average percentages of the seven pickers composing the crew on that date were 1 per cent clipper cuts and 0.6 per cent long stems. An examination of the work of the different individuals shows that one man (picker No. 4) was doing practically all of the clipper cutting, his average being 6.4 per cent; it will also be noted that his average of long stems (2.8 per cent) was greater than that of any of the other pickers. If it was impossible for this workman to improve the character of his picking he should have been discharged. Without him the average percentage of clipper cuts would have been reduced to 0.7 per cent and of long stems to 0.5 per cent.

TABLE VIII. *-Imperfections found during three inspections of one picking crew, showing great improvement.*

Picker No.	Jan. 14, 1911.		Jan. 20, 1911.		Mar. 4, 1911.	
	Clipper cuts.	Long stems.	Clipper cuts.	Long stems.	Clipper cuts.	Long stems.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	5.2	3.6	0	5.4	1.1	0.5
2	1.1	6.1	0	3.6	.5	.5
3	9.5	4.1	1.0	9.2	.5	2.0
4	1.1	25.1	4.8	4.8	6.4	2.8
5	.....	.....	1.0	4.5	.6	.6
6	.....	.....	.6	3.5	1.2	1.8
7	.....	.....	.6	3.4	.5	.5
Average	5.4	9.9	.9	5.1	1.0	.6

While these figures plainly demonstrate the practicability of training a crew of pickers to do careful work, permanent improvement can not be accomplished without continuous attention to the details of inspection and constant urging of the workmen to better efforts. There are cases where picking operations were improved as long as the men thought that inspections would be made; as soon as these were discontinued, however, it frequently happened that the character of the work changed, and injuries again became common. Continual vigilance is therefore the prime requisite for carrying on picking operations in such a way that the number of injuries can be held at a minimum.

PROPER FIELD EQUIPMENT.

The efficiency of the foreman and of the picking force in general is frequently lowered by poor field equipment. In some instances associations of Florida growers have spent large sums in building and equipping modern packing houses, while their field outfits and methods have been neglected and consequently are so crude that the expensive packing-house equipment is of practically no value in so far as careful handling of the fruit is concerned.

A frequent source of injury is the clipper. Unless the shears are systematically inspected by the foreman they soon become dull and loose at the joint, and clipper cuts and long stems are almost sure to follow. It has not been uncommon to see a crew of pickers using clippers so dull and worn that it was impossible to make a close, clean cut. Clippers with rounded or blunted points should also be supplied in order to run no risk of puncturing the fruit.

The type of picking receptacle used is fundamentally important. Next to poor clippers, probably more injury is caused by poor picking sacks than by any other form of equipment. The old type of gunny sack, holding from three-fourths of a box to a full box of fruit, is still in use to some extent. Such a sack is so long that it is almost impossible to avoid pressing it against the ladder and branches. Moreover, it is made of such loosely woven material that the fruit may easily be punctured by thorns or twigs, and it is so heavy and unwieldy when filled with fruit that the picker can not always prevent injuries of this kind. The most objectionable feature, however, is the fact that the fruit must be emptied through the top of the sack into the field box, and even with the best of care the oranges must drop a foot or more when emptied in this way.

The best type of sack is one which opens at the bottom, so that it may be placed in the field box before being emptied and the fruit allowed to roll out gently without any appreciable drop. The mouth should be partly closed, so as to make it impossible for the picker to toss or drop the fruits into it. The material of which it is made

should be heavy enough to protect the fruit from thorns or twigs, and the capacity should not be more than half that of a large, standard field box. With a bag of this size and texture it is comparatively easy for the picker to protect the fruit from bruising against the ladder or branches. The wicker basket in use in some districts is supposed to prevent injuries from pressure, but it has several objectionable features. It is, first of all, awkward to handle. The wide mouth is an additional disadvantage, as it tempts the picker to drop the fruit; moreover, the large open baskets have no equals as collectors of dry twigs, leaves, and other trash. Some baskets open at the bottom, but from most of them the oranges must be emptied through the top, thus entailing a considerable drop.

The defects of the ordinary field box have already been discussed. Smaller boxes made of lighter material than those now used in most groves are to be recommended.

INFLUENCE OF CLEANING OPERATIONS UPON DECAY.

NECESSITY FOR WASHING.

On account of the wide distribution throughout Florida of the white fly and its attendant sooty mold, the washing of citrus fruits has become a necessity in most sections of the State. In some localities where the fly has not yet become prevalent washing is practiced in order to give the fruit a higher polish and to improve its appearance. The removal of dust and stains can be equally well accomplished by dry brushes, however, and the risk of infection is not so great. During the past few years there has been a great increase in the proportion of fruit washed or otherwise cleaned until now the practice is very general throughout the State. The investigations of the Bureau of Plant Industry included a study of the relationship of washing or other cleaning operations to the amount of decay developing after the fruit is packed, and the results indicate that the extent of the deterioration from decay varies with the character of the work done in the cleaning processes. As a general rule, any operation to which the fruit is subjected increases the chance for injury and consequent decay. Well-grown fruit, comparatively free from stain or rust, is sufficiently attractive without being cleaned. Demonstrations with both California and Florida citrus fruits have shown that receivers in eastern and northern markets can not distinguish between washed and unwashed packs if the fruit is at all clean when it comes from the grove. From the viewpoint of the effect of any particular operation upon the subsequent behavior of the fruit, the soundest policy is one which will reduce to the lowest possible minimum the processes to which the fruit is subjected in the course of its preparation for shipment. Washing is perhaps the severest treatment that can be given to citrus fruits, and wherever it is not absolutely necessary in order to render the fruit marketable it should be omitted. When oranges have been exposed to attacks of the white fly, washing or some other cleaning process is imperative because of the sooty mold, consequently a large proportion of the fruit must always be subjected to this treatment. The importance of having the work carried on in such a way that as little damage as possible will result becomes doubly urgent when it is considered that the washing processes offer ideal conditions for the spread of blue mold.

Wherever washing and subsequent drying are practiced, the combined operations are the most complicated processes through which the fruit is put in the packing house. They involve extra handling of the fruit and accordingly furnish additional opportunities for mechanical injury. The results of the bureau investigations clearly show that decay in the packed fruit is largely due to injuries received or aggravated during the operations of washing and drying, although it is difficult, if not impossible, to indicate any particular point at which most of the injury takes place. The results of the Florida experiments show that where injuries to the fruit were confined almost

wholly to those received in the commercial field-handling operations the decay was practically the same as in the case of lots where injuries were confined to those received in the washing and drying operations. From this the assumption may be drawn that the bad effects following washing are due not so much to actual injuries made in passing the fruit through the machine as to the inoculation of injured and bruised spots through the agency of dirty, infected water. There seems to be a definite relationship between the type of field handling and the occurrence of decay following washing. Injuries made in the grove, punctures from long stems, or other damage received as the oranges pass through the machinery are aggravated by the addition of moisture, especially when the water is not clean. On the other hand, the quality of work performed by the machinery is largely dependent upon the manner in which the fruit is handled in the grove, and this consideration emphasizes the necessity of careful and systematic methods, especially where washing must be employed. Fruit which is handled in groves and packing houses with sufficient care to insure its packing without injury usually shows much less decay after washing than the same or similar fruit which has been treated less carefully.

Fruit which is covered with sooty mold must be thoroughly soaked before it is in proper condition for washing. This introduces a prolific source of infection—the soaking tank. Unless the water in the soaking tank is kept sanitary by being frequently changed, it soon becomes heavily charged with blue-mold spores, and is then one of the most dangerous features of the washing operations. As yet, no disinfectant has been found which proves effective against blue mold. Extensive investigation of this phase of the subject has shown the spores to be so resistant that any solution used to destroy them must be of sufficient strength to injure the surface of the fruit. The importance of maintaining the soaking tank in a sanitary condition is therefore fundamental. It should be emptied frequently, and sprays of fresh water should be directed against the fruit as it passes through the washing machine.

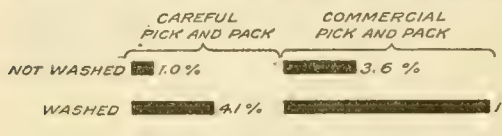

FIG. 10.—Diagram illustrating the percentage of blue-mold decay after holding oranges, washed and not washed, for two weeks in a packing house; summary of all experiments, 1910–11.

RESULTS OF WASHING EXPERIMENTS.

Tables IX, X, and XI, and figures 10, 11, and 12 show the results obtained during the season of 1910–11, when the washing experiments of the bureau were carried on in a comprehensive and systematic manner, giving the average percentages of decay found in carefully and commercially handled fruit, washed and not washed, respectively. The fruit was packed as if for shipment, but instead was held for two weeks in the packing houses and the percentages of decay determined by actual count. Table IX and its accompanying diagram (fig. 10) present a summary of all the washing experiments carried on during the season, including the work of 13 different types of machines, operated in 32 packing houses. The figures show the relative increase in decay due to the washing operations alone in the case of the carefully handled fruit and to the combination of causes in the case of the commercially handled fruit. The carefully handled oranges, not washed, showed 1 per cent of decay after two weeks; the washed, 4.1 per cent. In the commercially handled lots, the fruit not washed showed 3.6 per cent of decay and the washed fruit 10.2 per cent. The figures include the results of work done in many different ways, and while they summarize the general effects of washing, some analysis of the data is necessary in order to bring out the points of fundamental importance.

TABLE IX.—*Blue-mold decay after holding oranges, washed and not washed, two weeks in packing house; summary of all shipments, 1910–11.*[1]

Treatment.	Careful pick and pack.	Commercial pick and pack.
	Per cent.	*Per cent.*
Not washed	1.0	3.6
Washed	4.1	10.2

[1] Results of 37 experiments in 32 packing houses, in which 13 different types of washers were used.

Table X and its accompanying diagram (fig. 11) show the wide variation in the amount of decay found in five houses selected for careful work, as compared with five houses chosen for rather careless work. While the average percentages of decay in the washed fruit of the five better houses were only slightly higher than the percentages of decay in the fruit not washed, it will be noted that the cleaning operations in the five careless houses increased the amount of decay to a material extent, even in the carefully picked and packed fruit. The significant point to be noted in these results is that the washing operations were conducted in the careful houses in such a way that little or no harm ensued, while in the more careless houses they were followed by serious injury. It is impossible to state definitely whether this result was due to the use of different types of machines or to the more careful operation of the machinery in the five best packing houses. It is probable, however, that both factors were in some degree responsible. Observation has shown that careless manipulation of the best machinery is frequently followed by as serious deterioration of the fruit as is the careful handling of less desirable types of machines.

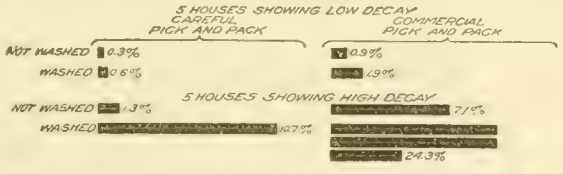

FIG. 11.—Diagram illustrating the percentage of blue-mold decay appearing after holding oranges, washed and not washed, for two weeks in a packing house, showing high compared with low decay in carefully handled and commercially handled fruit.

TABLE X.—*Blue-mold decay after holding oranges, washed and not washed, two weeks in a packing house, showing high and low decay in fruit carefully handled and commercially handled, 1910–11.*

Packing houses and treatment.	Careful pick and pack.	Commercial pick and pack.	Packing houses and treatment.	Careful pick and pack.	Commercial pick and pack.
5 houses showing low decay:	*Per cent.*	*Per cent.*	5 houses showing high decay:	*Per cent.*	*Per cent.*
Not washed	0.3	0.9	Not washed	1.3	7.1
Washed	.6	1.9	Washed	10.7	24.3

In order to bring out the relationship between field handling and packing-house management, Table XI and its accompanying diagram (fig. 12) are presented. These give the results of experiments made at the same time in two houses in the same locality, the character of fruit handled in both houses being practically identical. Observation showed that the work of house No. 1 was careless, while in house No. 2 systematic management and careful methods prevailed. That the character of the fruit was the same is shown by the fact that the lots carefully picked and not washed showed a minimum percentage of decay in both cases. The fruit was held two weeks after

packing, and decay was determined by actual count. In house No. 1 the carefully handled fruit, not washed, was held for two weeks with only 1.1 per cent of decay, while the washed lot of the same fruit developed 14.1 per cent. The carefully handled oranges, not washed and washed, showed 0.8 per cent and 1 per cent of decay, respectively, in house No. 2. The commercially handled fruit, not washed, in house No. 1 developed 4.7 per cent of decay after two weeks, while in house No. 2 this class of fruit showed only 1.2 per cent of decay. There was 39.5 per cent of decay in the washed lots of commercially handled fruit from house No. 1, but in house No. 2 only 1.3 per cent of the fruit handled in the same way showed decay at the end of two weeks. The significance of the effects of rough field handling and subsequent poor manipulation of the machinery is amply shown, and the practicability of carrying on washing operations with care sufficient to reduce decay to a minimum is likewise demonstrated.

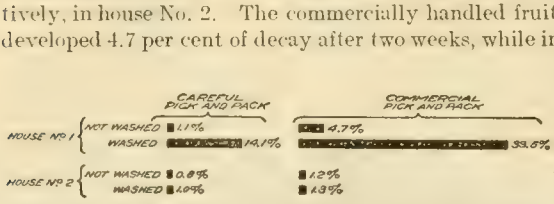

FIG. 12.—Diagram illustrating the percentage of blue-mold decay in oranges, washed and not washed, from two houses in the same locality, after holding the fruit for two weeks in the packing houses, 1910–11.

TABLE XI.—*Blue-mold decay in oranges, washed and not washed, from two houses in the same locality after holding the fruit for two weeks in the packing houses, 1910–11.*

Packing houses and treatment.	Careful pick and pack.	Commercial pick and pack.	Packing houses and treatment.	Careful pick pack.	Commercial pick and pack.
House No. 1:	*Per cent.*	*Per cent.*	House No. 2:	*Per cent.*	*Per cent.*
Not washed	1.1	4.7	Not washed	0.8	1.2
Washed	14.1	39.5	Washed	1.0	1.3

In the bureau investigations 12 different types of washing machines and one sawdust cleaner were used. A few of the machines were of such evident impracticability that they were rapidly going out of use, and of those which gave satisfactory results it is manifestly impossible to name any one which is best suited for all purposes. The quantity of fruit to be handled and the nature of the work to be performed are important factors which must be considered in determining the value of any machine. When purchasing this part of the equipment, it is important to choose the type of machine which will do the best work from the standpoint of careful handling and will eliminate, as far as is possible, the detrimental results of washing.

Some of the features which should be avoided in washing machines are as follows:

(1) Completely inclosed brushes. The fruit should be in plain sight at all times.

(2) Pressure on the fruit other than that afforded by the weight of the fruit itself.

(3) Opportunity for the fruits to tumble over or rub against one another to any great extent.

(4) Any arrangement of brushes, mats, etc., which allows twigs, thorns, nails, etc., to become lodged in the runway through which the fruit must pass.

Any one of these features may be the means of much injury, especially in houses where careful attention to the operation of the machinery is not given at all times, or where the field-handling operations have been more or less careless.

IMPORTANCE OF DRYING.

Fruit should never be packed while moist or wet. Moisture is one of the prime requisites for the development of decay, and, as the temperature of the fruit during the Florida packing season is usually high enough to facilitate the germination of the

mold spores, the importance of having the fruit perfectly dry can not be too strongly emphasized. Weather conditions in Florida are practically never such that fruit may be allowed to stand wet in the boxes for several days, although this practice prevails to some extent in California. The wet conditions within the mass of fruit renders ideal the conditions for the development of any mold, especially where the packing-house premises are not strictly sanitary. Injured fruits handled in this way frequently develop decay which has not advanced far enough to be detected when the fruit passes over the grading belts and which might have been prevented by prompt drying. Later drying or even icing in transit can not entirely arrest the growth of the mold.

In some districts the sun rack (Pl. VII, fig. 2) is depended upon for drying the fruit, and with favorable weather conditions this method is as effective as the use of many of the so-called artificial-drying machines. The chief objection to this rack is that frequently sufficient space for its proper construction is not available, and it is therefore not made large enough to accommodate all of the fruit or to insure perfect drying. Moreover, the handling of the fruit on this rack is often very rough and conducive to severe injury, unprotected brooms or wooden implements being generally used to dislodge the fruit or to spread it over the rack as it comes from the washing machine. Another point of injury is where the fruit is allowed to run off the bottom of the rack into the field boxes, from which it is again emptied into a hopper leading to the grading machine. These various operations and the more or less rough type of handling greatly multiply the chances for injury and increase the liability of blue-mold infection.

The drying of fruit in Florida is difficult at best, and the artificial drier seems to be an ultimate necessity, at least from the standpoint of thorough work and careful handling. Frequently weather conditions are such that complete drying is practically impossible unless some artificial method is devised to evaporate the water from the surface of the fruit. A properly constructed drying machine can be adjusted so as to carry the fruit continuously from the washing machine to the grading belts, without drops, gravity runs, elevators, or even the use of the human hand. A machine which can thus be adjusted to carry on the work with proper care is more reliable than are workmen of the type usually employed in a packing house.

The artificial drying of fruits is still in the experimental stage in Florida, and a machine which will prove wholly satisfactory under all conditions has not yet been devised. All the types of mechanical driers have yielded good results under favorable weather conditions, and all have given more or less trouble on cloudy days or at any time when the humidity was very high.

In the most effective driers now in use, an air blast is circulated around the fruit in such a way that the moisture is more or less completely removed. The introduction of artificial heat or some other means of drying the circulating air will greatly improve the character of the work and will materially lessen the distance over which the fruit must travel. Other things being equal, the more promptly the drying can be accomplished the less chance there will be for the development of blue mold.

PACKING AND SHIPPING EXPERIMENTS.

EXPERIMENTAL CONSIGNMENTS DURING TWO SEASONS.

During the seasons of 1910–11 and 1911–12 comprehensive series of shipping experiments were made in order to demonstrate the application of the results of the packing-house tests made during previous years. More than 90 experimental shipments of oranges were made from Florida in 1910–11, and 65 shipments were sent out in the course of the work during 1911–12. These consignments were composed of fruit from practically every orange-growing district in the State, including the Manatee River district, the Pinellas Peninsula, and the Hillsboro County sections on the west coast; the groves extending from Fort Myers to De Land in the interior; and

the section along the east coast from Daytona and New Smyrna to Miami. They represented a great variety of conditions and formed a fair average of the character of the fruit in the State, as well as of the manner in which it was prepared for market under commercial conditions. Some of the best as well as some of the poorest houses were represented in these tests, and a number of houses which may be classed as average were also included.

Each shipping series consisted of six boxes of oranges; two of these were carefully picked, graded, and packed by the bureau workers; two were picked by regular pickers but were carefully graded and packed; and the last two were taken from the ordinary commercial run of the houses from which the experimental shipments were made. The shipments were divided into two parts. In one the grading, packing, and shipping were made on the same day on which the fruit was picked, or as soon afterwards as possible, and in the other the same fruit was held for three or four days in the packing house before packing and shipping. The former were designated as "immediate" and the latter as "delayed" shipments. All lots were sent out with the regular carloads of fruit from the various packing houses, and the experimental boxes were expressed to Washington from the northern markets to which the cars were consigned. Each box was inspected on the day of arrival in Washington and the percentage of decay accurately determined. The fruit was held for three weeks under ordinary open-market conditions, and inspections were made at the end of the first, second, and third weeks. The results obtained give a fair representation of the average decay occurring in a commercial pack and show the percentage of loss which can be avoided by more careful handling.

Plate XV illustrates the condition in which the three lots shipped from one packing house using very little care arrived on the Washington market. The carefully picked, graded, and packed fruit (on the left in the illustration) showed 4 per cent of decay on arrival; the commercially picked but carefully graded and packed fruit (in the center) showed 35.6 per cent of decay, and the commercially handled fruit (on the right) had 65.9 per cent of decay. After intervals of one, two, and three weeks the three lots, respectively, showed decay as follows: After one week, 4 per cent, 46 per cent, and 71.6 per cent; after two weeks, 11.5 per cent, 54 per cent, and 72.2 per cent; after three weeks, 11.5 per cent, 57.1 per cent, and 72.2 per cent.

Table XII and figure 13 show the average percentages of decay found in the shipments during 1910–11 and 1911–12.

TABLE XII.—*Blue-mold decay in oranges carefully handled and commercially handled, on arrival in Washington and after holding for three weeks; average of all inspections, 1910–11 and 1911–12.*[1]

Time of examination.	Careful pick and pack.		Commercial pick and careful pack.		Commercial pick and pack.	
	1910–11	1911–12	1910–11	1911–12	1910–11	1911–12
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
On arrival	0.6	0.6	2.5	1.4	7.0	4.0
After 1 week	1.1	.9	4.3	2.2	10.8	6.8
After 2 weeks	1.6	1.4	5.5	3.5	13.1	10.4
After 3 weeks	1.9	2.2	6.1	5.5	14.2	14.2

[1] From 79 comparable shipments made in 1910–11 and 65 comparable shipments made in 1911–12.

Table XIII and its accompanying diagram (fig. 14) summarize the results of the two seasons' work and show the average of all experiments carried on during the two years. In the illustration the results are marked as curves, using the percentages of decay for the vertical lines and the times of arrival and of holding for the horizontal lines. In this way the progress of the deterioration can readily be traced, and the influence of the different systems of handling upon the occurrence of decay is strikingly shown.

The carefully handled fruit arrived in Washington during both seasons with less than 1 per cent of decay, or an average for the two years of 0.6 per cent. The commercially picked but carefully packed fruit showed much more decay on arrival, while a still higher percentage of decay had developed in the fruit picked and packed under ordinary commercial conditions. The average percentage of decay which was developed in the carefully picked and packed fruit during a holding period of three weeks was about the same as that shown on arrival by the commercially picked but carefully packed lots. The fruit handled under commercial conditions throughout

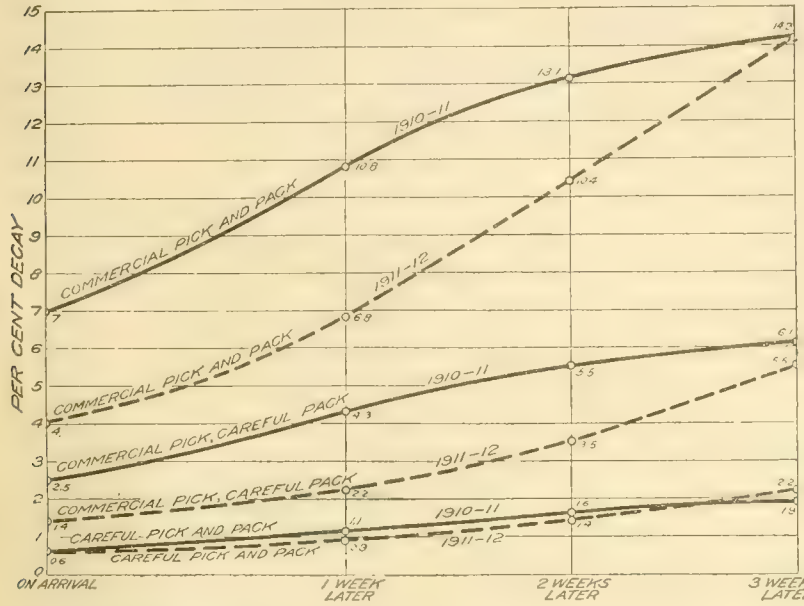

FIG. 13.—Diagram illustrating the percentage of blue-mold decay in carefully handled and commercially handled oranges on arrival in Washington and after holding for three weeks; average of all inspections, 1910–11 and 1911–12.

had developed more than twice as much decay by the first inspection as occurred in the carefully picked and packed fruit at the end of three weeks. The latter boxes, with 2.1 per cent of decay, were still in good marketable condition after holding for three weeks under ordinary market conditions, but the commercially handled fruit had developed 5.5 per cent of decay on arrival, which was increased to 14.2 per cent at the end of three weeks.

TABLE XIII.—*Blue-mold decay in oranges carefully handled and commercially handled, on arrival in Washington and after holding for three weeks; summary of the results of the two seasons' work, 1910–11 and 1911–12.*[1]

Time of examination.	Careful pick and pack.	Commercial pick and careful pack.	Commercial pick and pack.
	Per cent.	*Per cent.*	*Per cent.*
On arrival	0.6	2.0	5.5
After 1 week	1.0	3.3	8.8
After 2 weeks	1.5	4.5	11.8
After 3 weeks	2.1	5.8	14.2

[1] From 79 comparable shipments made in 1910–11 and 65 comparable shipments made in 1911–12.

These results strongly emphasize the very definite relationship which exists between the type of handling given the fruit in preparing it for shipment and its behavior during transit, and they show that the condition of the fruit after arrival in market depends largely upon the character of the work done in the grove and the packing house. They also show that the Florida orange, when properly handled, has excellent shipping qualities and that practically all loss from blue-mold decay, such as has occurred in the past, can be eliminated. This is the fundamental factor upon which will eventually depend the successful marketing of the crop as well as the extension of the territory over which sound fruit can be distributed. The importance of having the fruit remain in good condition after arrival in market is most urgent. Carefully handled fruit which has good keeping quality will always command a premium over fruit which has a bad reputation. The former will enable buyers to break up carloads and to ship sound fruit to smaller markets over an area two or three times as large, while

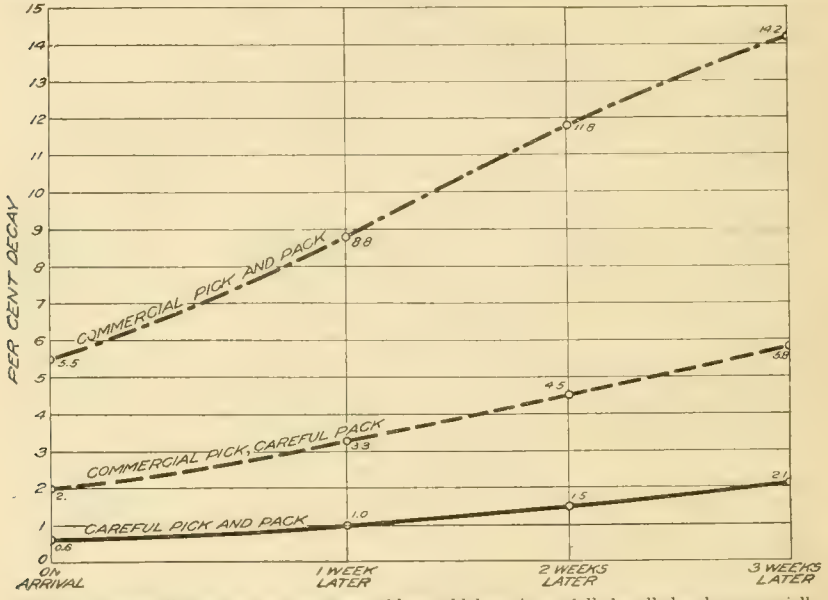

FIG. 14.—Diagram illustrating the percentage of blue-mold decay in carefully handled and commercially handled oranges on arrival in Washington and after holding for three weeks; summary of the results of the two seasons' work, 1910–11 and 1911–12.

fruit of a less desirable quality must be consumed quickly in order to avoid further serious loss. Moreover, aside from the actual saving of fruit, the reputation of a brand which holds well on the market can not be adequately estimated in dollars and cents.

EFFECT OF DELAYED SHIPMENT.

Experiments with delayed shipments were made in order to determine the effect of "curing" fruit before packing. One of the strongest traditions which existed among packing-house men in the past was that curing was necessary in order that the fruit might be in proper condition for packing. The slight wilting and consequent softening of the oranges was supposed to enable the packer to place them more firmly in the box. The results of the shipping experiments carried on during the two seasons did not show that there was any advantage to be gained from curing. Contrary to the general belief that cured fruit is less easily injured in packing, the average decay in the delayed lots was considerably higher than in the immediate shipments. Table XIV and figures 15, 16, and 17 give the average percentage of decay found in the

immediate and delayed shipments during the seasons of 1910–11 and 1911–12. Sufficient data have been accumulated to indicate that carefully handled fruit may be cured without serious loss, but that wherever the fruit has been appreciably damaged in the course of its preparation for shipment, decay is materially greater in the delayed lots. The carefully handled immediate and delayed shipments during 1910–11 and 1911–12 arrived with 0.5 per cent and 0.7 per cent of decay, respectively, the difference being so slight that it may be neglected entirely. The commercially handled immediate shipments showed 4.6 per cent of decay and the delayed ones 6.6 per

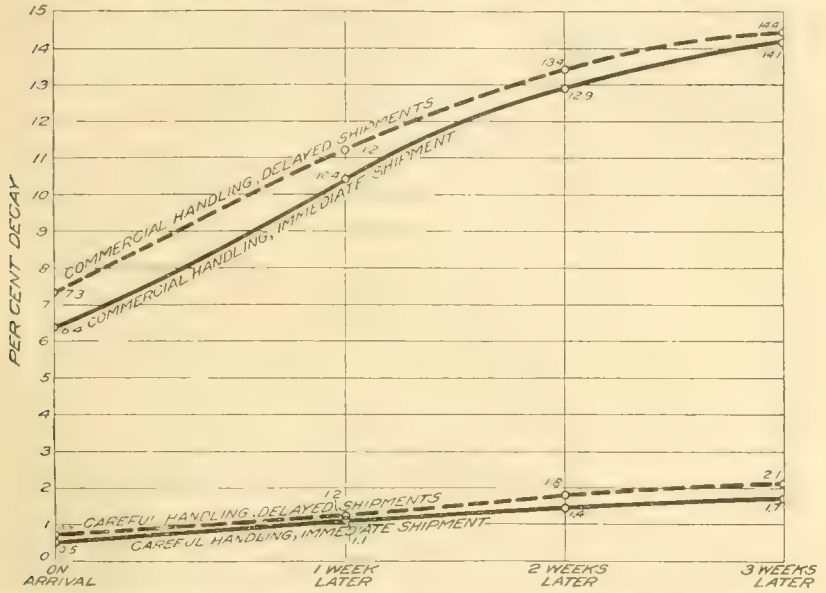

FIG. 15.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots and in immediate and delayed shipments, 1910–11,

cent on arrival. After holding these lots of fruit for three weeks the decay in the carefully handled fruit had increased to 2 per cent, while the commercially handled shipments showed 13.8 per cent of decay for the immediate and 14.8 per cent for the delayed ones. Once again the effect of careful handling upon the behavior of the fruit after arrival in market is strikingly shown.

TABLE XIV.—*Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled and in immediate and delayed shipments, 1910–11 and 1911–12.*[1]

Time of examination.	Careful pick and pack.			Commercial pick and pack.		
	1910–11	1911–12	Average 2 seasons.	1910–11	1911–12	Average 2 seasons.
On arrival:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Immediate	0.5	0.5	0.5	6.4	2.9	4.6
Delayed	.7	.7	.7	7.3	5.8	6.6
After 1 week:						
Immediate	1.1	.9	1.0	10.4	5.7	8.1
Delayed	1.2	1.0	1.1	11.2	8.7	9.9
After 2 weeks:						
Immediate	1.4	1.4	1.4	12.9	9.7	11.3
Delayed	1.8	1.5	1.7	13.4	11.7	12.5
After 3 weeks:						
Immediate	1.7	2.3	2.0	14.1	13.5	13.8
Delayed	2.1	2.0	2.1	14.4	15.1	14.8

[1] From 39 comparable shipments made in 1910–11 and 28 comparable shipments made in 1911–12.

The prevailing opinion that fruit packed soon after picking or before it has had time to cure will arrive in slack condition has not been borne out by the bureau investigations. When the fresh fruit is firmly and properly placed in the box, it is no more liable to make a slack pack than is the cured fruit. It is probably true that the latter can be more easily packed, for less effort is required to press it into the box. The work of many rapid packers who make no effort to place the oranges firmly and who rely upon the press to squeeze the fruit into place, is conducive to poor carrying quality as well as to slackness. Each layer must be properly placed. Where the press is depended upon to shove the fruit down into the box the force exerted reaches through only two or three layers and often squeezes the oranges in these to the extent of breaking the skin or inflicting serious bruises. After the boxes are loaded on the cars, jolting during transit loosens the improperly packed layers, and the fruit arrives on the market in a slack condition. When every orange is firmly placed, however, there is little chance that such slackening will result.

Moreover, fruit held loose in the packing house during warm, humid weather is afforded an additional opportunity for blue-mold infection. Although some packers

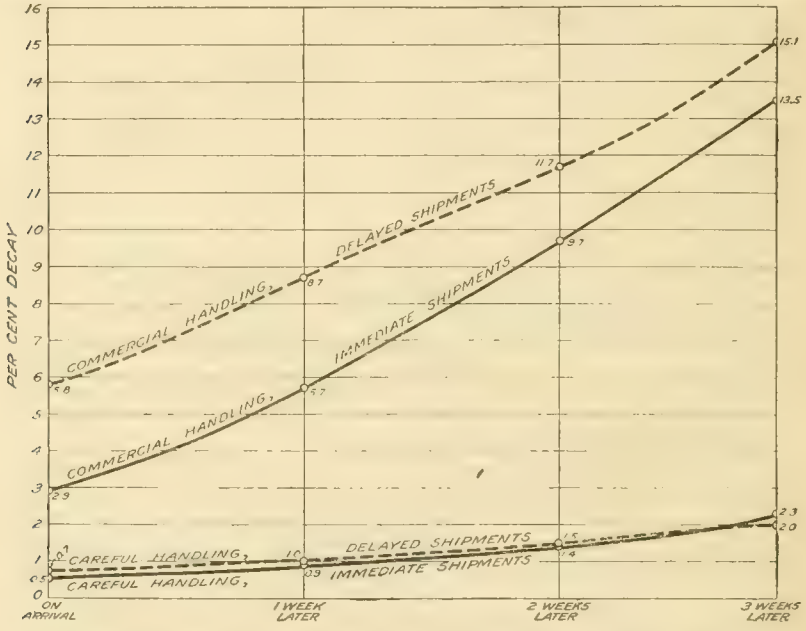

FIG. 16.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots and in immediate and delayed shipments, 1911–12.

consider this delay necessary in order to eliminate the injured oranges which have begun to decay, experience and observation show that while graders are occasionally able to discern and throw out such fruits, it is practically impossible to discover all infected specimens. The development of blue mold during the curing period accounts for the advanced stages of the decay usually found in delayed shipments on arrival in market.

The average length of time during which the experimental shipments were in transit from Florida to Washington was 10 days; as a rule, from 8 to 10 days are required for Florida oranges to arrive at their destination. Several days may then elapse before the fruit is sold, and a still longer period usually intervenes before it is placed in the hands of the consumer. The 3-weeks' period used in the Washington market-holding tests represents approximately the length of time required to finally dispose of the

fruit. When the fruit is held for 3 or 4 days in the packing house the period elapsing between picking and final consumption is unnecessarily and even dangerously lengthened. From this standpoint alone curing is unwise, as the delay increases the chance for the infection of bruises or injured spots and facilitates the development of decay before shipment and in transit.

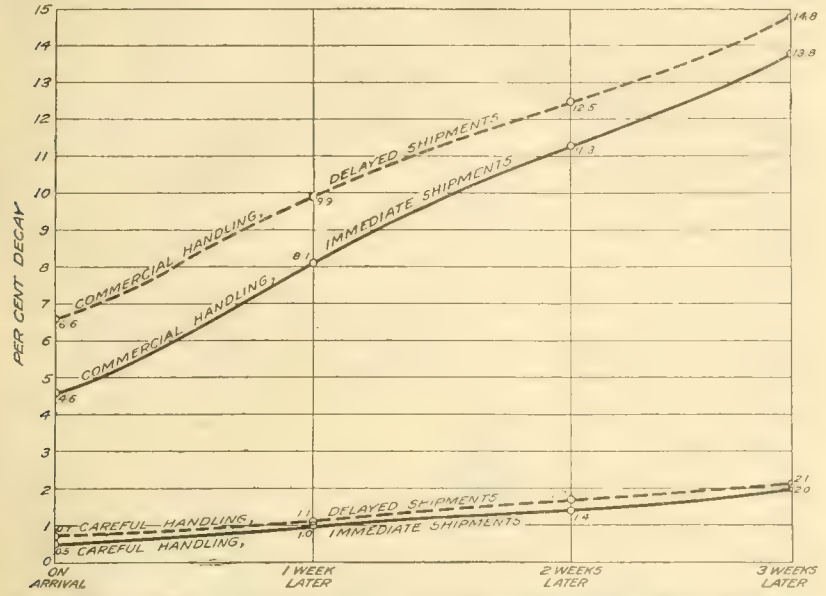

FIG. 17.—Diagram illustrating the percentage of blue-mold decay of oranges, on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots and in immediate and delayed shipments; average of the two seasons, 1910–11 and 1911–12.

A comparison of commercially handled immediate and delayed shipments from two packing houses, in one of which the work was being done very carefully, while in the other the handling was of a rather rough character, emphasizes the relationship which exists between delay and the occurrence of decay while in transit. Table XV and its accompanying diagram (fig. 18) give the results of commercial shipments from these two packing houses during the season of 1910–11. The houses were located in the same district and the fruit was similar in character.

TABLE XV. *Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, the immediate and delayed shipments from two houses, 1910–11.*

Time of examination.	House No. 1.		House No. 2.	
	Immediate.	Delayed.	Immediate.	Delayed.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
On arrival	0	0	26.1	67.3
After 1 week	1.2	.6	40.4	71.3
After 2 weeks	3.1	1.4	42.6	71.9
After 3 weeks	4.0	1.4	42.8	71.9

The fruit from house No. 1, which was carrying on the work in a careful manner, arrived in Washington with no decay in either immediate or delayed lots, and after holding for three weeks the immediate shipments developed 4 per cent of decay, while the delayed ones had less than 2 per cent. In house No. 2, where the work was being carelessly done, the difference between the percentages of decay was very

great. It will be noticed that even in the immediate shipments the proportion of decayed oranges amounted to 26.1 per cent on arrival and at the end of three weeks constituted 42.8 per cent of the total. In the delayed shipments, 67.3 per cent of decay had developed on arrival, and this was increased to 71.9 per cent after three weeks. This is an extreme case, of course, and it is only fair to state that few houses in Florida were doing as poor work as this during 1910–11. The figures are presented to emphasize the contrast between commercial work performed under different conditions.

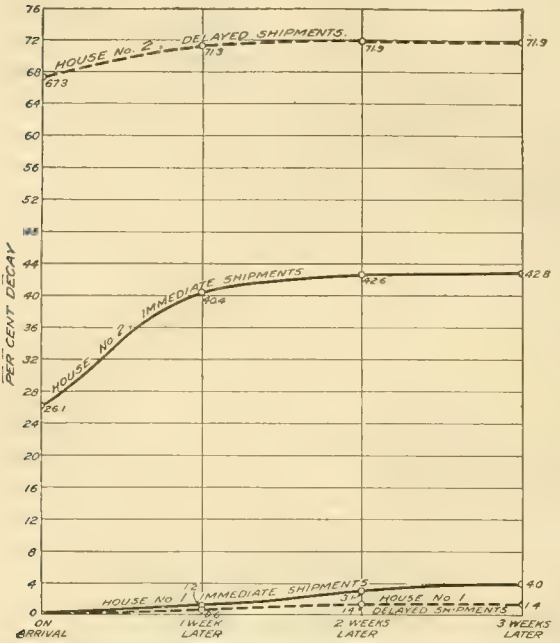

FIG. 18.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in immediate and delayed shipments from two houses, 1910–11.

Table XVI and its accompanying diagram (fig. 19) give the results of immediate and delayed shipments of fruit from a single packing house during the period when high decay is usually most prevalent in Florida. The work done in this house could not be considered as first class. For the sake of contrast, immediate and delayed lots carefully handled by the bureau workers were sent out at the same time as the commercially handled shipments. The carefully handled fruit, shipped immediately, arrived in Washington with 1 per cent of decay, while the commercially handled oranges showed 5.1 per cent. The carefully handled delayed lot had developed 3.6 per cent of decay on arrival, while the commercially handled delayed shipment showed 36.9 per cent at the same time. After holding the carefully handled fruit in Washington for three weeks, the immediate shipment was still in very good marketable condition with only 2 per cent of decay, whereas the percentage in the delayed lot had increased to 6.3. The latter fruit was still marketable, although subject to discount. Both lots of commercially handled fruit, however, developed decay far in excess of any market allowance, the immediate lot showing 25.6 per cent and the delayed 44 per cent.

TABLE XVI.—*Blue-mold decay of oranges in immediate and delayed shipments from one house, on arrival in Washington and after holding for three weeks during a period of high blue-mold decay, December, 1911.*

Time of examination.	Carefully handled fruit.		Commercially handled fruit.	
	Immediate.	Delayed.	Immediate.	Delayed.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
On arrival	1.0	3.6	5.1	36.9
After 1 week	1.0	4.6	16.5	38.0
After 2 weeks	1.2	5.3	23.3	39.4
After 3 weeks	2.0	6.3	25.6	44.0

Unless unfavorable weather conditions prevail, a delay of several days is not serious under a system of careful handling which insures the packing of the fruit in sound condition, but it is far better to avoid delay as much as possible, even if the attendant conditions are most favorable.

COMPARISON OF THE WORK OF DIFFERENT PACKING HOUSES.

Typical rough and careful handling.—The figures presented in Tables XVII to XX and the accompanying diagrams include the averages of both commercial and experimental shipments from a number of houses representing all classes of work. Extremes of rough handling and consequent very high decay during transit, as well as extremes of careful handling accompanied by excellent shipping quality, were found in different parts of the State.

Table XVII and its accompanying diagram (fig. 20) give the average percentages of decay occurring during 1910–11 and 1911–12 in the commercial shipments from 12 houses using care and from a like number of houses in which the work was roughly done. During both seasons the percentage of decay in the commercial fruit shipped by the houses using care was almost as low as the average for any of the carefully handled lots, picked, graded, and packed by bureau workers. The practicability of conducting commercial operations with sufficient care to eliminate decay is thus plainly demonstrated. The results of the two series of shipments present a striking and consistent contrast throughout both seasons. The averages of the carelessly handled commercial lots were somewhat lower during 1911–12 than they were in 1910–11, but the proportion of decayed fruit on arrival (10.9 per cent) is still too high for good commercial results.

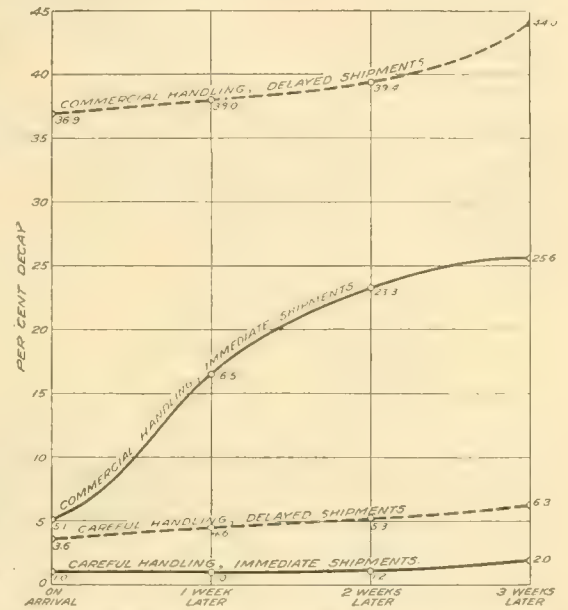

FIG. 19.—Diagram illustrating the percentage of blue-mold decay of oranges in immediate and delayed shipments from one house, on arrival in Washington and after holding for three weeks during a period of high decay, December, 1911.

TABLE XVII.—*Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in shipments showing high and low blue-mold decay in careful and in commercial pack, 1910–11 and 1911–12.*

Year.	Inspection.	12 shipments showing low decay.		12 shipments showing high decay.	
		Careful.	Commercial.	Careful.	Commercial.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1910–11	On arrival	0.1	0.4	0.4	14.6
	After 1 week	.2	.8	.8	22.2
	After 2 weeks	.2	1.3	1.5	27.8
	After 3 weeks	.3	1.6	2.1	30.8
1911–12	On arrival	.1	.6	1.1	10.9
	After 1 week	.3	1.7	1.3	16.1
	After 2 weeks	.6	3.0	1.7	20.5
	After 3 weeks	1.2	4.4	2.7	25.9

Table XVIII and figure 21 give the average percentages of decay of oranges from two packing houses in the same locality working on practically the same kind of fruit. The type of work in house No. 1 was good, but that in house No. 2 was rather poor. These shipments were made at the same time, and the results of carefully handled lots prepared by the bureau workers from the same houses are given for comparison.

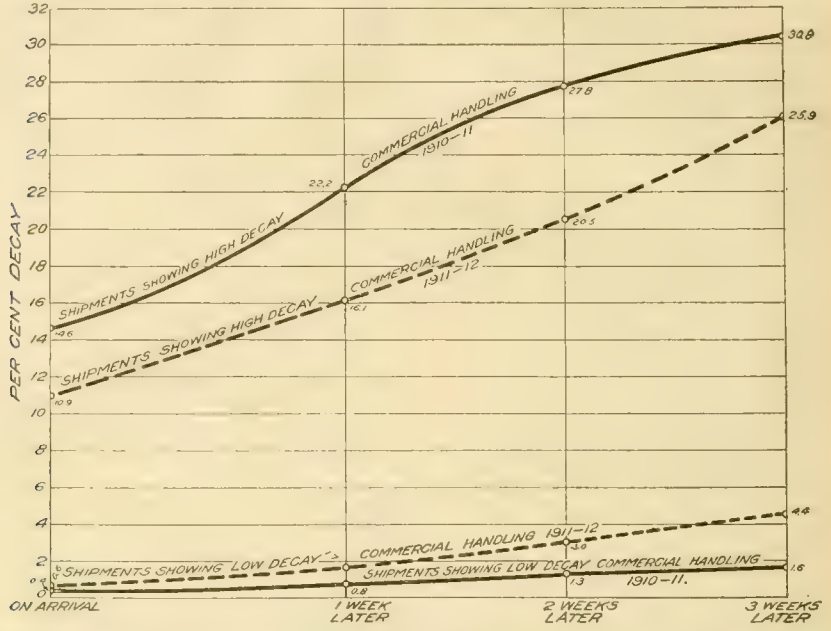

FIG. 20.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in shipments showing high compared with low decay in commercial pack, 1910–11 and 1911–12.

TABLE XVIII.—*Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots shipped from two houses in the same locality, 1910–11.*

Time of examination.	House No. 1.		House No. 2.	
	Careful.	Commercial.	Careful.	Commercial.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
On arrival	0.4	2.4	0.3	21.3
After 1 week	1.5	4.5	.3	28.9
After 2 weeks	1.8	5.7	.3	48.2
After 3 weeks	2.5	5.7	.7	59.5

It will be noticed that the commercial shipment from house No. 1 gave practically as favorable returns as the specially prepared shipments of the bureau workers, the difference being only 2 per cent, both series from this house having less than the commercial allowance of 3 per cent decay on arrival. The commercial shipments from house No. 2, where observation showed the handling to be rather careless, had developed 21.3 per cent of decay on arrival at Washington, while the fruit handled by the bureau workers at the same time and shipped under identical conditions showed 0.3 per cent of decay. After three weeks the commercial shipments from house No. 1 averaged 5.7 per cent of decay, and those from house No. 2 showed 59.5 per cent, as against 2.5 per cent and 0.7 per cent, respectively, for the carefully handled fruit.

Relation of character of picking to decay.—A study of field handling in connection with the occurrence of decay in commercial shipments was made in two packing houses in Florida during 1911–12. It would be hard to find a more striking illustration of the effects of careless handling than that presented in Table XIX and in the diagram (fig. 22). It should be borne in mind that all of these results were obtained from lots of commercially handled fruit, no attempt being made by the bureau workers to influence the type of handling. They merely inspected the field work and made sure that the boxes selected for experimental shipment were representative.

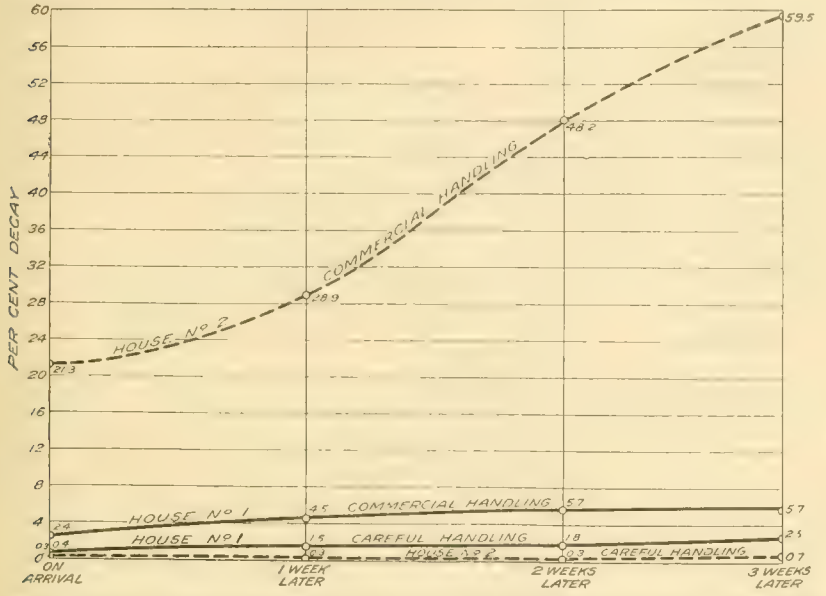

FIG. 21.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots shipped from two houses in the same locality, 1910–11.

In house No. 1, where the type of handling was fairly good, the proportion of clipper cuts was 0.2 per cent; of pulled fruit, 1.6 per cent; and of long stems, 4 per cent. The immediate shipments of this fruit showed no decay on arrival, while the delayed lots had 3.7 per cent. After holding three weeks in market, 6 per cent and 8.2 per cent of decay developed in the immediate and delayed shipments, respectively.

TABLE XIX. *Imperfections in picking and the percentage of blue-mold decay of commercially handled oranges on arrival in Washington and after holding for three weeks, from two houses in the same locality, 1911–12, showing the effect of careful handling on the carrying quality of fruit.*

Class of imperfections.	Picking inspections.	
	House No. 1.	House No. 2.
	Per cent.	*Per cent.*
Clipper cuts	0.2	7.4
Long stems	4.0	56.8
Pulled	1.6	.1

TABLE XIX.—*Imperfections in picking and the percentage of blue-mold decay of commercially handled oranges on arrival in Washington, etc.*—Continued.

Time of examination.	Experimental shipments.			
	House No. 1.		House No. 2.	
	Immediate.	Delayed.	Immediate.	Delayed.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
On arrival	0	3.7	8.0	19.4
After 1 week	1.5	5.2	12.0	23.0
After 2 weeks	2.7	6.7	15.6	27.4
After 3 weeks	6.0	8.2	22.4	34.5

In house No. 2, which was selected for rough handling, the percentage of clipper cuts was 7.4 per cent; of pulled fruit, 0.1 per cent; and of long stems, 56.8 per cent. The immediate shipments from this house showed an average of 8 per cent decay on arrival and the delayed shipments 19.4 per cent, these percentages being increased to 22.4 and 34.5, respectively, after three weeks in Washington.

The relationship between the type of field handling and the behavior of the fruit while in transit has been definitely established by numerous experiments during several seasons. The experiment cited above fairly represents the general character and results.

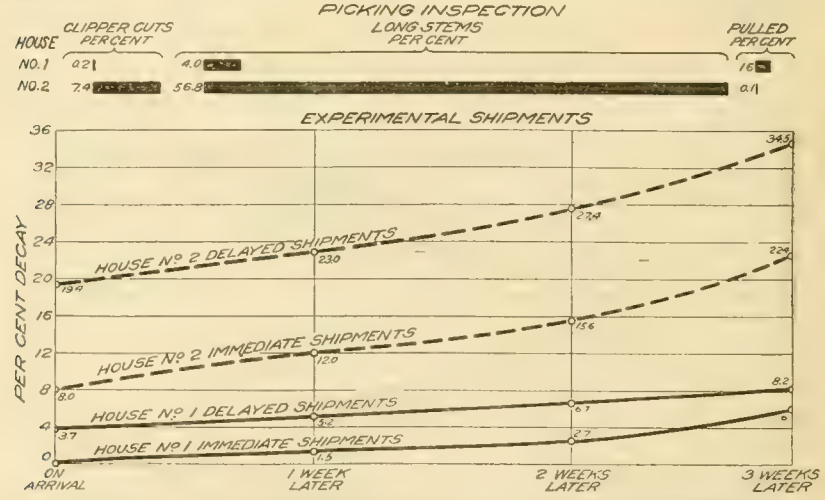

FIG. 22.—Diagram illustrating the percentage of imperfections in picking and the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in commercially handled lots from two houses in the same locality, 1911–12, showing the effect of careful handling on the carrying quality of the fruit.

The figures presented in Table XX and the accompanying diagrams (figs. 23 and 24) are shown to indicate the practicability of improving the handling and shipping conditions by giving special attention to the organization of the labor forces. The packing house from which the data were obtained was reorganized at the end of the 1910–11 season; the machinery was simplified and every effort was directed toward the introduction of better handling methods. Two experimental shipments were made—one during 1910–11 and one during 1911–12, two lots being sent out each season. The results of the inspections of the field work are given to show the great improvement in the second season, the results of careful handling by the bureau workers being also included for comparison with the commercial work done during the two seasons.

TABLE XX.—*Imperfections in picking and the percentage of blue-mold decay of fruit on arrival in Washington and after holding for three weeks, shipped from one packing house during 1910–11 and 1911–12, showing decrease in blue-mold decay due to greater care in handling.*

Class of imperfections.	Picking inspections.			Time of examination.	Experimental shipments.			
	1910–11		1911–12		1910–11 [1]		1911–12 [2]	
	Jan. 17.	Mar. 3.	Dec. 13.		Careful.	Commercial.	Careful.	Commercial.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Clipper cuts	11.3	5.7	1.8	On arrival	0.2	8.0	0.3	1.1
Long stems	23.0	11.9	10.4	After 1 week	.6	12.6	.9	2.4
Pulled	1.0	5.1	1.4	After 2 weeks	.8	15.3	1.2	2.8
				After 3 weeks	1.3	15.8	1.5	4.1

[1] Fruit picked Feb. 1, 1911. [2] Fruit picked Dec. 13, 1911.

It will be noticed that in 1910–11 (fig. 23) the total imperfections in the field handling amounted to 35.3 per cent at the first inspection and 22.7 per cent at the second. The average percentage of decay in the commercial shipments was 8 per cent on arrival at Washington, the carefully handled lots developing 0.2 per cent. In 1911–12 (fig. 24) the field work, while far from perfect, was considerably improved, the inspections showing 13.6 per cent of imperfections. The commercially handled fruit showed 1.1 per cent of decay on arrival, and the lots prepared by the bureau workers had 0.3 per cent. After holding the fruit in Washington for three weeks the commercially handled oranges developed 15.8 per cent of decay during 1910–11 and 4.1 per cent during 1911–12. When it is considered that the variation in the percentage of decay for these two seasons may easily mean a difference between profit and loss in the sale of the fruit from this house, the data presented become particularly impressive. It would be difficult to assemble a stronger array of facts than those brought together in this figure to illustrate the fundamental importance of preserving the sound carrying quality of oranges. The significance of the connection between field handling and the occurrence of decay during transit is definitely shown, as well as the practicability of improving conditions by means of more systematic management. This presentation should be sufficient to convince even the most skeptical that loss from decay in the shipment of Florida oranges is dependent upon the character of handling given the fruit in field and packing house.

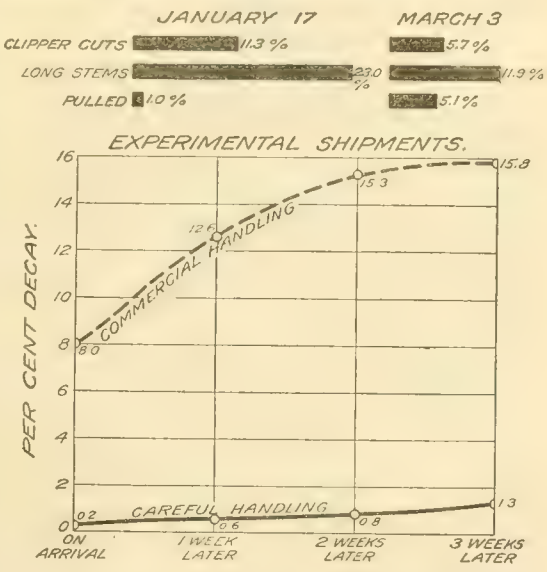

FIG. 23.—Diagram illustrating the percentage of imperfections in picking and the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in fruit shipped from one packing house, showing decrease in blue-mold decay due to greater care in handling, 1910–11.

RESULTS FROM A FINANCIAL STANDPOINT.

In order to emphasize the importance of careful work, the data may be analyzed from a financial standpoint. The results are perhaps more impressive when expressed in dollars and cents than when a statement is made regarding the percentages of decay in various lots of fruit.

The difference between the average percentages developed in the carefully picked and packed and the commercially picked and packed fruit during the season of 1910–11 was 6.4 per cent. This means that 1 out of approximately every 15½ boxes shipped during the season was unnecessarily destroyed by blue-mold decay, and that this loss might have been avoided if the fruit had been handled with care approximating that given by the bureau workers. It is only necessary to extend this line of reasoning. Out of every 100 boxes of fruit shipped, the avoidable loss was 6½ boxes; therefore, on a basis of 3,500,000 boxes of oranges shipped from Florida during the season of 1910–11 this loss aggregated 224,000 boxes, which at a fair f. o. b. price of $1.50 per box gives a direct money loss of $336,000.

In 1911–12 the difference in decay between the carefully handled and commercially handled fruit was 3.5 per cent, or a loss of 1 box for every 28½ boxes shipped. A fair estimate of the total shipment of oranges during that season is 3,750,000 boxes. The loss on this fruit, at the rate indicated, aggregates 131,250 boxes, which, figured at prevailing prices, may be valued at approximately $200,000. Perhaps this is an exaggerated method of analyzing the true condition of affairs, yet when one takes into consideration the immense financial outlay necessary to pick, haul, grade, and pack these oranges, the actual money loss is not far from the amounts stated.

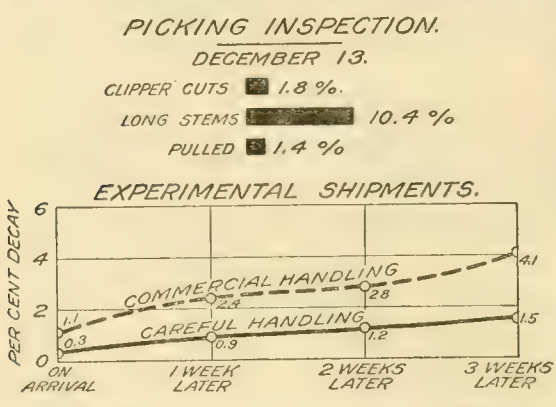

FIG. 24.—Diagram illustrating the percentage of imperfections in picking and the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in fruit shipped from one packing house, showing decrease in blue-mold decay due to greater care in handling, 1911–12.

The figures stated above approximate the net loss to the growers due to decay. In addition, there is a large loss due to the cost of transporting and selling. According to statistics recently compiled, it costs from $1.75 to $1.93 to produce, prepare for shipment, and deliver in market one packed box of oranges.[1] With this cost as a basis, the losses reached the stupendous totals of $432,320 during 1910–11 and approximately $250,000 during 1911–12.

From the standpoint of the effect upon the reputation of the Florida product the financial loss is even greater. It is impossible to give such a loss in actual figures, for the value of a reputation for high shipping and holding quality can not be estimated in dollars and cents. It is safe to say that the introduction of more careful methods would not increase the cost of handling to any material extent. No figures are available for such an increase, but the extra expense would certainly be only a small fraction of the actual money loss enumerated above. Leaving out of consideration the desirability of a good reputation, these figures should serve to convince those people who can appreciate values only from a financial standpoint that careful handling is necessary for the success of the industry.

[1] Statements of J. C. Chase and W. C. Temple before the Committee on Ways and Means, U. S. House of Representatives, 1913.

SEASONAL INFLUENCES ON THE OCCURRENCE OF DECAY.

It has been the general experience that blue-mold decay is more prevalent in Florida during the early months of the shipping season than it is later. Losses are most severe in December and January, the former month as a rule having the highest percentage of decay. So characteristic has this early deterioration been in the past that growers have become convinced that the underlying causes are not confined to improper methods of handling, and that the loss is due to some disease other than blue mold. Careful observation on the part of the bureau workers has shown this impression to be incorrect. An analysis of the circumstances under which fruit is handled during December shows that at that time of the year the conditions for the development of blue mold are particularly favorable. Rains are more or less prevalent and the humidity is generally high. It follows, therefore, that the type of handling which might suffice under favorable weather conditions will not then prove satisfactory.

In addition to bad weather conditions, the character of work done during the early part of the season is undoubtedly less careful than what is practiced later on. Shippers are in a hurry to get their fruit on the market in time for the holiday trade, and most of the workmen have not had sufficient experience. It seems impracticable, in Florida at least, to hold field and packing-house labor together throughout the year and to maintain a permanent organization. New pickers must therefore be trained each season, the same being true in the case of the packing-house labor, although probably to a less extent. These factors tend to lower the standard of early handling operations.

All the experiments made by the Bureau of Plant Industry emphasize the importance of systematic organization of the labor forces and careful handling of the fruit in every stage of its preparation for shipment. Every effort should be directed toward maintaining the fruit in sound condition from the time it is picked until it is unloaded at its final destination and placed in the hands of the consumer. During unfavorable seasons, frequent thorough inspections of the various operations through which the fruit passes are most essential. Instead of lowering the standard at this time, it is extremely important to approach the ideal as closely as possible.

In Tables XXI and XXII and figures 25 and 26, the percentages of decay occurring during the months of December, January, and February in 1910–11 and 1911–12 are presented. Table XXI and figure 25 show the decay in the carefully handled and commercially handled experimental shipments on arrival in Washington during December, January, February, and March, for both seasons. During December, 1910, the average percentage of decay in commercial shipments, on arrival at Washington, was 13.9 per cent. During December, 1911, the corresponding lots showed 9.4 per cent on arrival. The careful shipments during these months had 2.3 per cent in 1910 and 1.3 per cent in 1911, respectively.

TABLE XXI.—*Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, by months, in 1910–11 and 1911–12.*

Time of examination.	Careful pick and pack.		Commercial pick and pack.		Time of examination.	Careful pick and pack.		Commercial pick and pack.	
	1910–11[1]	1911–12[2]	1910–11[1]	1911–12[2]		1910–11[1]	1911–12[2]	1910–11[1]	1911–12[2]
On arrival:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	After 2 weeks:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
December	2.3	1.3	13.9	9.4	December	4.3	2.1	21.6	14.1
January	.5	.6	6.8	4.0	January	1.6	1.4	14.5	10.1
February	.5	.2	6.2	1.6	February	1.4	1.0	12.4	9.6
March	.3	.....	5.0	.....	March	1.0	.....	8.5	.....
After 1 week:					After 3 weeks:				
December	3.4	1.7	19.1	12.2	December	4.4	2.8	22.2	17.2
January	1.1	.9	11.4	6.8	January	1.9	2.2	15.8	13.5
February	.9	.4	10.2	4.5	February	1.7	2.0	13.3	14.2
March	.6	.....	7.3	.....	March	1.2	.....	9.6	.....

[1] The figures for 1910–11 include 7 comparable shipments for December, 28 for January, 28 for February, and 16 for March.

[2] The figures for 1911–12 include 8 comparable shipments for December, 39 for January, and 18 for February.

Averaging the results for December, 1910 and 1911, the commercially handled fruit showed 11.6 per cent of decay on arrival and the carefully handled 1.8 per cent. During the months of January, 1911 and 1912, the decay of oranges shipped under commercial conditions was 6.8 per cent and 4 per cent, respectively. The corresponding carefully handled fruit showed 0.6 and 0.5 per cent, respectively, or practically the same for both years.

During February commercially handled fruit showed 6.2 per cent of deterioration on arrival at Washington in 1911, the percentage of decay for the following year being 3.6 per cent. The average of the February lots for the two seasons was 3.9 per cent. Carefully handled fruit during 1911 and 1912 arrived with 0.5 and 0.2 per cent of decay, respectively, the average for the two years being 0.3 per cent.

No experimental shipments were made later than February during the second season. In March, 1911, the average percentage of decay in commercial shipments was 5 per cent on arrival, the carefully handled lots showing only 0.3 per cent.

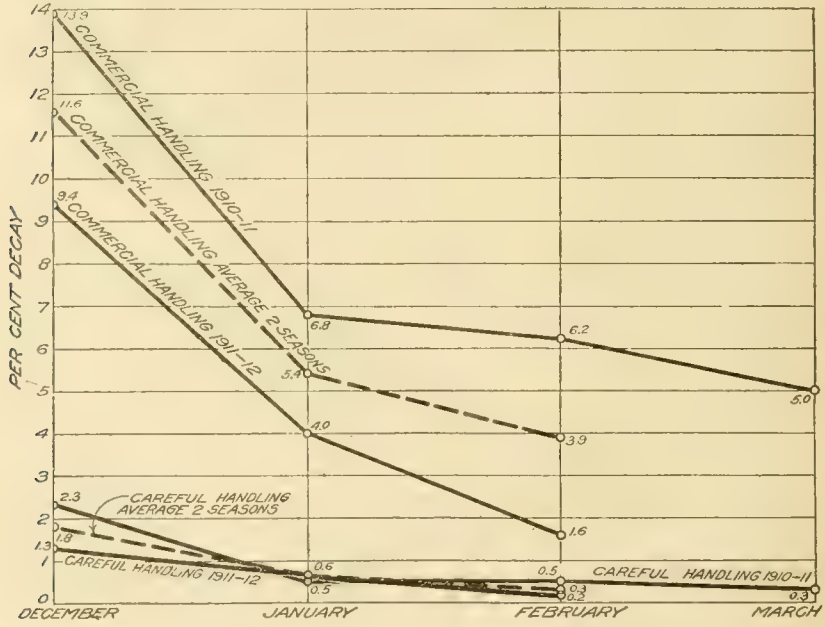

FIG. 25.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival, by months, during two seasons, 1910–11 and 1911–12.

These figures are significant in that they show a very high percentage of decay during December, followed by a gradual decrease as the season advances. This is true for both commercially and carefully handled fruit, although in the case of the latter the loss was, without exception, below the usual 3 per cent commercial allowance. It is scarcely probable that decay can be held below this point even with the best system of handling, for it is practically impossible to eliminate every injured orange or to carry on the handling operations in such a way that absolutely no injury is done. The general principle that very slight injury will result in decay when weather conditions are favorable for the development of blue mold is substantiated by these figures, and the importance of extra care during the early months is again emphasized.

Table XXII and figure 26 show the average percentages of decay found in fruits shipped during December, January, and February, 1910–11 and 1911–12, on arrival at Washington and after holding for three weeks under ordinary market conditions.

TABLE XXII.—*Blue-mold decay of oranges on arrival in Washington and after holding for three weeks; average of the two seasons, by months, in 1910–11 and 1911–12.*

Time of examination.	Careful pick and pack.	Commercial pick and pack.	Time of examination.	Careful pick and pack.	Commercial pick and pack.
On arrival:	*Per cent.*	*Per cent.*	After 2 weeks:	*Per cent.*	*Per cent.*
December	1.8	11.6	December	3.2	17.8
January	.6	5.4	January	1.5	12.8
February	.3	3.9	February	1.2	10.5
After 1 week:			After 3 weeks:		
December	2.5	15.7	December	3.6	19.7
January	1.0	9.1	January	2.1	14.6
February	.7	7.3	February	1.8	13.8

The commercially handled fruit, picked and shipped during December, showed the highest average percentage of decay on arrival (11.6 per cent), and the increase after three weeks was correspondingly higher than was the case for fruit picked and shipped during January and February. Commercially handled fruit, picked and shipped during January, arrived with 5.4 per cent of decay, and that sent out during February showed 3.9 per cent on arrival. The shipments of carefully handled fruit arrived with an average of 1.8 per cent during December, 0.6 per cent during January, and 0.3 per cent during February, and after holding for three weeks showed 3.6 per cent, 2.1 per cent, and 1.8 per cent of decay, respectively. All of the carefully handled fruit, even that shipped during December, showed much less decay after three weeks in market than the commercial shipments during February showed on arrival. The superior shipping and market-holding qualities of carefully handled fruit are evident.

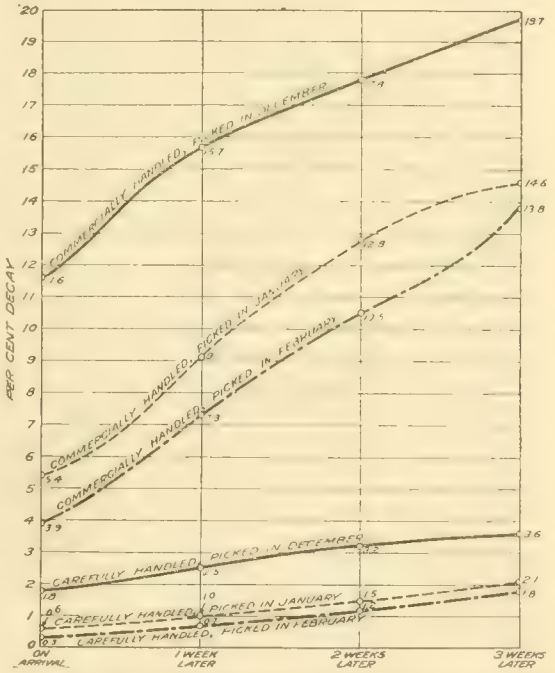
PER CENT DECAY
COMMERCIALLY HANDLED, PICKED IN DECEMBER
COMMERCIALLY HANDLED, PICKED IN JANUARY
COMMERCIALLY HANDLED, PICKED IN FEBRUARY
CAREFULLY HANDLED, PICKED IN DECEMBER
CAREFULLY HANDLED, PICKED IN JANUARY
CAREFULLY HANDLED, PICKED IN FEBRUARY
ON ARRIVAL
1 WEEK LATER
2 WEEKS LATER
3 WEEKS LATER

FIG. 26.—Diagram illustrating the percentage of blue-mold decay in carefully handled and commercially handled oranges picked during December, January, and February; average of the two seasons, 1910–11 and 1911–12.

PRECOOLING.

The term "precooling" has been used to designate the prompt and rapid cooling of fruit prior to shipment. The initial cooling of the product is accomplished very slowly when the fruit is shipped under ordinary icing conditions, the ice of a refrigerator car not being able to cool the fruit with sufficient promptness and rapidity to

prevent the development of decay. Consequently, deterioration is often far advanced before the temperature of the fruit is reduced to the point where these processes are checked. Under a system of precooling, the ice of the refrigerator car is relieved of the burden of initial cooling and is merely required to keep the fruit cool during transit.

Precooling is accomplished by means of special equipment, the refrigerating medium being either ice and salt or special refrigerating machinery. When adequate equipment is supplied, the initial temperature of the fruit may be reduced in a comparatively short time. The work may be done in refrigerated rooms or chambers before the boxes are placed in the cars, or it may be accomplished by circulating cold air around the packages after loading. The comparative advantages and limitations of these two systems can not be discussed here, but a few important points regarding the application of precooling to the shipment of Florida oranges must be emphasized.

Precooling may not safely be depended upon to offset decay following mechanical injuries due to improper methods of handling the fruit when preparing it for shipment. It is, however, a valuable and legitimate means of insuring arrival on the market in sound condition after each grower, packer, and shipper has done his share in properly handling the fruit. Precooling, in order to be effective, must be accomplished promptly and rapidly. A considerable delay in applying the process may nullify all possible benefits and defeat the object for which the work is undertaken.

Icing has been practiced to a limited extent in Florida, but precooling has not as yet been attempted. The value of this method of shipment in marketing Florida oranges is largely problematical. Its advantages are likely to be overestimated if the general distribution and application of the processes are attempted without careful and systematic investigation. During the warm and humid weather usually prevalent in Florida in December and January, precooling may be of considerable benefit, provided always that it is not expected to offset the bad effects of careless or improper handling. During warm and humid weather, such as occurred during the months of December, January, and part of February of the season of 1912–13, oranges are injured more easily than under ordinary conditions and are more subject to decay from these injuries. Infection from the ever-present, blue-mold spores is almost certain, and stem-end decay or other diseases may gain considerable headway. Rapid cooling (precooling) may possibly delay the development of stem-end decay for a week or more after the fruit arrives in market. While precooling and refrigeration can not do more than to delay for a short time the occurrence and development of this disease, such delay may prove of material benefit.

Precooling may reduce the quantity of ice consumed during the trip to market by removing the necessity of cooling fruit at the beginning of the trip. Possibly during the winter season, when the weather is cool or cold along the route, fruit which has been precooled may be moved to its destination under the initial icing alone. Precooling is expensive, and unless a material advantage can be obtained thereby its application can not be justified. If a sum of money equal to the expense of precooling is expended in insuring careful handling of the fruit during the course of its preparation for shipment, the returns will probably be more certain and more lasting.

STEM-END ROT.

In addition to the losses from blue mold, there has been considerable deterioration of Florida citrus fruits after arrival in market due to the attacks of the stem-end decay fungus. Unlike blue mold, this fungus does not apparently depend upon injuries or breaks in the skin through which to gain entrance to the tissues of the fruit. Investigation during the season of 1910–11, in cooperation with the Florida experiment station, proved conclusively that the stem-end rot disease can not be controlled by

means of careful handling. The results of this investigation into the nature of the fungus, its manner of growth, and its development have been published by the Florida experiment station.[1]

SUMMARY.

The orange crop of Florida averages 4,000,000 or 5,000,000 boxes per year, and it has been estimated that, reckoning the good with the bad years, probably 10 per cent of the fruit decays before reaching the consumer. This entails an annual financial loss of at least half a million dollars. By far the most common form of decay is that caused by the growth of the blue-mold fungus within the tissues of the fruit, entrance being obtained only through some mechanical injury to the skin. The first researches of the Bureau of Plant Industry indicated that, owing to improper equipment in grove and packing house as well as to the carelessness of pickers and packers and their ignorance of the essential factors of good handling, considerable injury was being inflicted on the fruit in the course of its preparation for shipment. Most serious of all are the injuries inflicted by the clippers in severing the fruit from the tree and the punctures caused by the presence of long stems on the oranges. Many bruises or abrasions, especially those caused by dropping the fruit, can not be detected by packers and develop heavy decay in transit.

In most sections of the State cleaning the fruit has become a necessity, owing to the wide distribution of the citrus white fly and the development of the sooty-mold fungus which follows in the wake of that pest. At present probably 75 per cent of the Florida orange crop is cleaned either by washing or by the sawdust method. The Department investigations show that decay in transit or on the market is largely due to injuries received or aggravated during washing and drying and that these operations may be conducted in such a way that little or no harm ensues or may be followed by serious deterioration. The experiments of the Bureau of Plant Industry during the past seven years prove conclusively that the condition of the fruit after arrival in market depends largely upon the character of the work done in the grove and the packing house; that it is possible to so conduct the operations of picking, packing, and shipping as to inflict a minimum of mechanical injuries; and that uninjured Florida oranges can be placed on the market in practically sound condition even in seasons of very high decay. Practically all loss from blue-mold decay, such as has occurred in the past, can be eliminated.

The sizes of Florida oranges vary from 80 to 420 fruits in a box, the most common sizes being 126, 150, 176, and 200 to a box. The Florida shipping box measures 12 by 12 by 27 inches, inside dimensions, and has an estimated weight of 80 pounds when filled. The average shipment per car totals 321 boxes, loaded 2 tiers high. A standard shipping car is 33 feet long, 8 feet wide, and 8½ inches high; the minimum freight weight of a standard car of 300 boxes is 24,000 pounds. The average freight rate on citrus fruits from Florida during 1912-13 was 65.7 cents per box of 80 pounds weight.

During the past five years the Florida citrus industry has been reorganized and the changes have greatly improved the handling of the fruit. At the time the Department investigations were begun the methods of preparing oranges for shipment were extremely crude; there was no uniformity of system and the equipment was wholly inadequate to the needs of the industry. Of late years the old type of packing house has almost entirely disappeared. Modern houses, equipped with the newest machinery for handling fruit properly, have been constructed in practically every citrus district in the State, so that the industry is now well provided with the mechanical appliances for doing good work. Further reforms will include improvement of field equipment and more careful attention to the details of picking and to the organization

[1] Fawcett, H. S. Stem-end rot of citrus fruits. Florida Agricultural Experiment Station, Bulletin 106.

of the picking and packing crews. The men should be paid by the day instead of by the box, and a conscientious foreman should carefully oversee the work of the individual pickers. The bureau experiments prove that it is possible to train workmen to use more care and to greatly reduce their percentage of imperfections.

More than 90 experimental shipments of oranges were made from Florida in 1910–11, and 65 were sent out in 1911–12, including fruit from every section of the State and from good, poor, and average houses. Plate XV illustrates the condition in which some of these lots arrived in Washington. The carefully picked, graded, and packed fruit showed 4 per cent of decay on arrival, the commercially picked but carefully graded and packed fruit showed 35.6 per cent, and the commercially handled fruit had 65.9 per cent. After one week these percentages had increased to 4 per cent, 46 per cent, and 71.6 per cent, respectively; after two weeks they were 11.5 per cent, 54 per cent, and 72.2 per cent; and after three weeks, 11.5 per cent, 57.1 per cent, and 72.2 per cent.

The carefully handled fruit arrived in Washington during both seasons with less than 1 per cent of decay, or an average for the two years of 0.6 per cent for all the experimental shipments. The fruit handled under commercial conditions throughout had developed more than twice as much decay by the first inspection as occurred in the carefully handled fruit at the end of three weeks.

That commercial handling may also be careful handling is demonstrated by the fact that during both seasons the average percentage of decay in the commercial fruit shipped from 12 houses using care was almost as low as the average for any of the lots carefully handled by the bureau workers. In one packing house, where during 1910–11 the percentage of decay in the commercially handled fruit reached 15.8 per cent after holding for three weeks in Washington, the handling operations were so improved by the adoption of the bureau methods that during 1911–12 only 4.1 per cent of decay developed in the commercially handled fruit at the end of the same period.

It has been the general experience that blue-mold decay is more prevalent in Florida during the early months of the shipping season than it is later. All of the fruit carefully handled by the bureau workers, even that shipped during December, showed much less decay after three weeks in market than the commercial shipments during February showed on arrival. The shipping experiments showed that carefully handled fruit may be "cured" without serious loss, but that whenever the fruit has been appreciably damaged in the course of its preparation for shipment, decay is materially greater in the delayed lots.

Although not more than 1 per cent of the total shipments of citrus fruits had previously been iced, during 1912–13 a considerable number of commercial shipments were sent north under refrigeration. No systematic study was made of the behavior of fruit of the same grade and quality under the two systems of shipment, but the general opinion seems to prevail among shippers that the icing resulted in material benefit to the fruit. The investigations of the Bureau of Plant Industry have demonstrated, however, that Florida oranges may be transported to market under ventilation with a minimum loss from decay, even during periods of warm and humid weather, if sufficient care is used to preserve the skin of the fruit in an unbroken condition.

CONCLUSIONS.

In the light of the principles established by the workers of the Department of Agriculture in the investigations and experiments of the past seven seasons, viz, that the condition of the fruit after arrival in market depends largely upon the character of the work done in grove and packing house, and that it is possible to so conduct the operations of picking, packing, and shipping as to inflict a minimum of mechanical injuries

from which decay may develop, the following points are recommended to the attention of growers and shippers of Florida citrus fruits:

Workmen, especially pickers, should be paid by the day and not by the quantity of work done.

More careful attention to the details of picking and to the organization and inspection of the picking crews is necessary. Each member of the crew should be held responsible for the character of his work. An efficient field foreman should supervise the pickers, watch their output, and insist on careful handling. He should be prohibited from picking fruit himself.

Clippers with rounded or blunted points should be supplied. These should be frequently inspected by the foreman to prevent their becoming dull or loose at the joint.

Picking sacks of heavy material, which have partially closed mouths, allowing the fruit to be emptied from the bottom, and having a capacity of not more than half of a large standard field box, should be used.

Pickers should not pull the fruit from the tree. All oranges should be severed by means of the "double cut."

Fruit should be placed carefully in the picking sack and not dropped or tossed in.

The picking sack should be lowered into the field box and the oranges allowed to roll out gently without appreciable drop.

No fruit should be picked up from the ground and placed in the field boxes.

Smaller field boxes of lighter materials are recommended.

The fruit should not project above the top of the field box, and the latter should be transported to the packing house on a spring wagon. The driver should be given an especially prepared seat and not allowed to sit on the fruit.

Each picker and packer should be required to wear gloves.

Picking receptacles, field boxes, and packing bins should be kept free of gravel, twigs, splinters, protruding nails, or other foreign matter.

The efficiency of the packing house may be spoiled by a desire to save floor space. Simplicity should govern the choice and disposal of all equipment.

The desirable hopper is small, has padded sides, and allows the fruit to be emptied gradually by means of moving belts. The fruit should not fall by gravity at any stage of its journey.

Uniform and definite grading rules should be established for the State.

Wherever washing is not absolutely necessary in order to render the fruit marketable it should be omitted.

Water in the soaking tank should be frequently changed, and sprays of fresh water should be directed against the fruit as it passes through the washing machine.

The best type of washing machine has the fruit in plain sight at all times, allows no pressure on the oranges save that afforded by their own weight, does not allow the fruits to tumble over or against each other, and does not allow twigs, thorns, nails, etc., to become lodged in the runway through which the fruit must pass.

Fruit should never be packed while moist. An artificial drier in which a warm air blast is circulated around the fruit seems to be a necessity from the standpoint of thorough work and careful handling.

The sawdust method of cleaning grapefruit is ineffective as well as highly injurious.

Loose packs of fruit are more liable to be injured in transit than those of medium height with every orange firmly in place.

Decayed fruit should not be left in the boxes or allowed to accumulate on the floor or under the packing bins in the packing houses.

Curing is unwise, as the delay increases the chance for the infection of bruises or injured spots and facilitates the development of decay before shipment and in transit.

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During unfavorable seasons, especially during December and January, when warm and humid weather is prevalent in Florida, frequent thorough inspections of the various operations through which the fruit passes are most essential. Instead of lowering the standard at this time, it is extremely important to approach the ideal as closely as possible.

Precooling may not safely be depended upon to offset decay following mechanical injuries due to improper methods of handling the fruit when preparing it for shipment, but it is a valuable and legitimate means of insuring arrival on the market in sound condition after each grower, packer, and shipper has done his share in properly handling the fruit.

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